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HEADQUARTERS

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CONTENTS

It is regretted that, in spite of the already considerable delay, it has not been possible to publish Professor Friel's Northcroft Memorial Lecture in these Transactions.—
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An Analysis of Serial Models between Three and Eight Years of Age

Lilah M. Clinch, B.A., F.D.S., R.C.S.

About five years ago I examined and took impressions of 100 children between three and four years of age who had all been born at Perivale Maternity Hospital and details of whose birth histories were available. They were an unselected group who attended the local health centres. My intention at the time was to find out if any malocclusions or malformations of the jaws could be correlated with the type of birth presentation. The result was negative as I have shown elsewhere. But I was interested to find that a high percentage of these young children had malocclusion and I decided to follow them up and to find out how these cases developed and also exactly how the process of replacing the deciduous by the permanent teeth was affected in the normal as well as the abnormal dentitions. This paper describes the progress as far as the mixed dentition. In another three or four years it is hoped to complete the examination with the eruption of the 2nd permanent molars.

METHOD

Impressions were taken at approximately yearly intervals; it was not always possible to obtain the children at the end of each twelve months and some of the intervals are longer. I have limited this paper to those children with all deciduous molars erupted in the early models and with permanent incisors and first permanent molars in the final models. This, added to the number whom I was unable to follow up, has reduced the total to 61 series of four models at approximately yearly intervals.

Six measurements were taken, in millimetres, of each upper and each lower model as follows : (*Fig.* 1)

1. The external length of the arch, *i.e.*, the perpendicular distance from a line joining the distal surfaces of the second deciduous molars to the labial surfaces of the central incisors (A).

2. The internal length of the arch, *i.e.*, the perpendicular distance from a line joining the distal surfaces of the second deciduous molars to the mid point of the interdental space between the central incisors. (B).

3 and 4. The distance between the medial surfaces of the deciduous canine and the distal surfaces of the second deciduous molar on the right and on the left. (C).

5. The inter-canine breadth. This was measured at the widest points on the buccal surfaces of the deciduous canines. (D).

6. The extra-canine breadth. This was

Presidential address presented to the meeting on 8th January.

measured between the centres of the cinguli of the deciduous canines at the gum margin. None of the cases in this investigation had permanent canines. (E).

In addition six measurements of the relative positions of the upper to the lower teeth were also taken. These were the horizontal anteroposterior distance between:

1. The distal surface of the upper second deciduous molar and the medial surface of the lower canine on each side. (G).
2. The distal surface of the upper canine and the medial surface of the lower canine on each side. (F).
3. The distal surfaces of the upper and lower second deciduous molars on each side. (H).

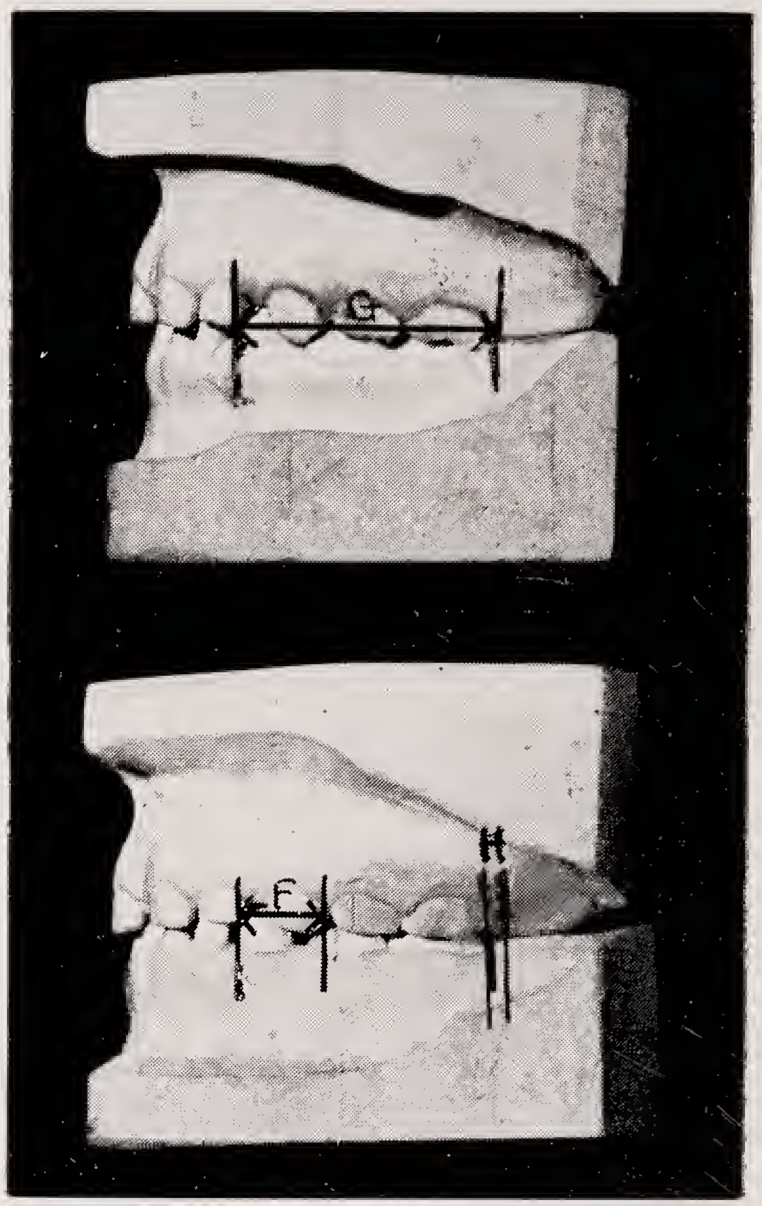


FIGURE 1

Distances measured. A, B. Internal and external arch length. C. Medial C to distal E. D and E. Inter and extra canine breadth. F. Distal $\underline{C}$ *to medial* $\overline{C}$. *G. Distal* $\underline{E}$ *to medial* $\overline{C}$. *H. Distal* $\underline{E}$ *to distal* $\overline{E}$.

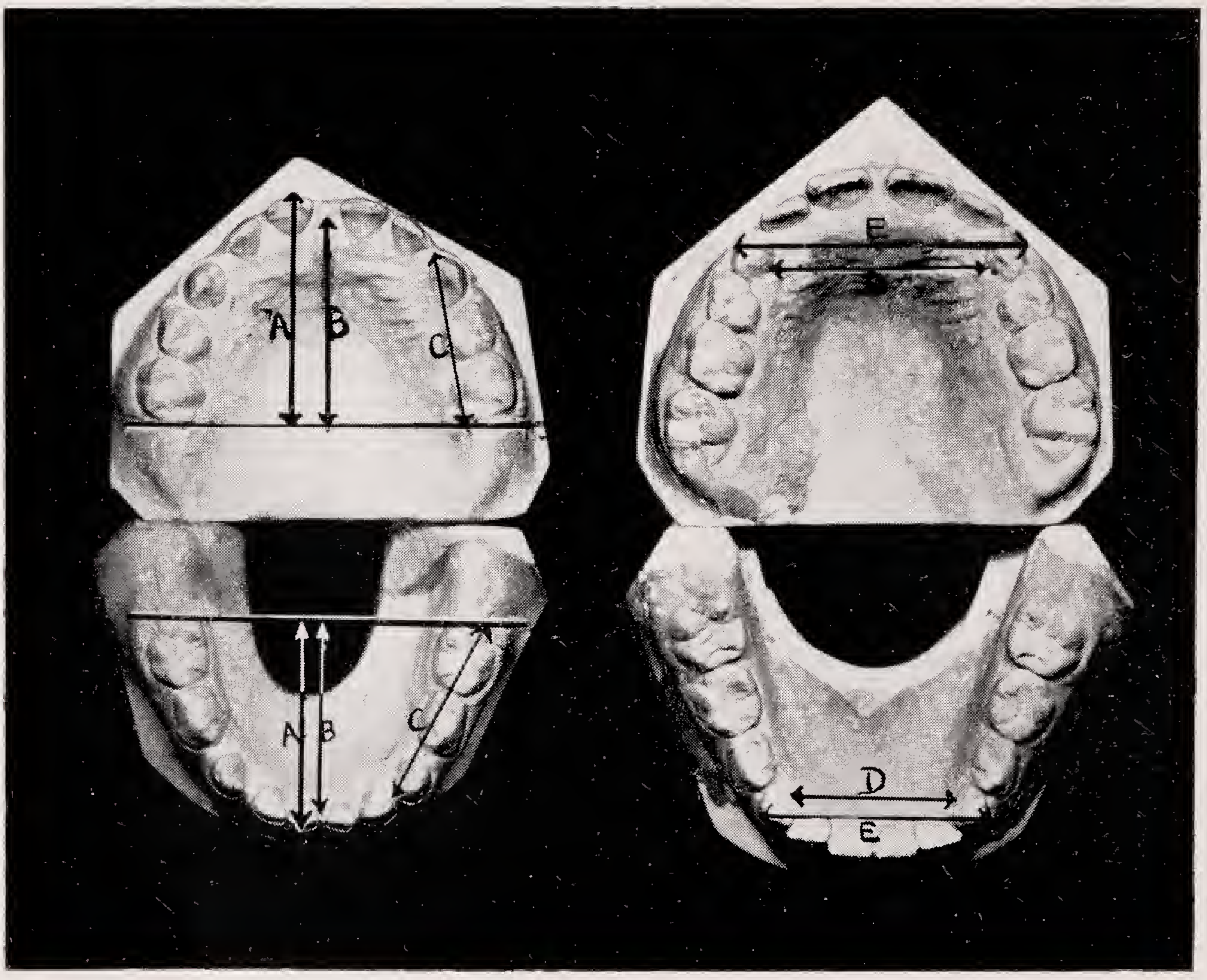


TABLE A

ARCH LENGTH

	NO.	MEAN INCREASE PER 10 MONTHS
Upper External	54	0.24 mm.
Upper Internal	54	0.14 mm.
Difference		0.10 mm. S
Lower External	58	0.10 mm.
Lower Internal	58	0.02 mm.
Difference		0.08 mm. N.S.

FINDINGS

Arch Length. Table A. In the upper arch during the period under investigation there was an increase in the external length and in the internal length. There was a significant difference between the two showing that part of the space necessary to accommodate the permanent incisors was obtained through their increased labioclination as compared to the deciduous incisors. It is likely that when all the permanent incisors are fully erupted the difference between the two measurements will be greater, due to a further increase in the external length. In the lower arch there was an increase in the external length and in the internal length. The difference was not significant. These small increases in lower arch lengths can be explained by the fact that the spaces between the canines and first deciduous molars tend to close with the eruption of the permanent molars and this is deducted from the arch length when measured from the distal surfaces of the deciduous molars. Table A shows the statistical analysis of the arch length measurements. As the period between the models varied hence the period between the measurements varied. It was therefore decided to divide the figures into periods of ten months all through the investigation for purposes of comparison and accuracy. (The mean percentage increase was also calculated but it varied little from the mean actual increase and is not therefore included in the tables.)

Arch Breadth. Tables B. & C. There was a small but statistically significant increase in the upper and in the lower in the inter-canine breadth of the arches before the eruption of the permanent incisors. During their eruption however there was a greater increase in the upper and in the lower. After the eruption of the permanent central incisors the increase continued but to a reduced extent. The number of cases having reached this stage was small. Table B shows the changes per ten months before, during and after the eruption of the permanent incisors, and also the total increase over the period of the investigation. The average increase in the extra-canine breadth in the upper arch showed no significant difference from the increase in the inter-canine breadth. In the lower however, the difference was significant between the increase in the extra-canine breadth and that in the inter-canine breadth. It appears from the figures that there must be an increased labioclination of the lower canines. Table C shows the comparison between the inter-canine and extra-canine breadth per ten months.

TABLE B

ARCH BREADTH

Before, During and After the Eruption of the Permanent Incisors

Mean Increase per 10 *Months*

	NO.	BEFORE	NO.	DURING	NO.	AFTER
Upper	58	0.12 mm.	59	0.69 mm.	21	0.56 mm.
Lower	58	0.08 mm.	60	0.60 mm.	21	0.40 mm.

Upper:	Difference Between		Before and During	=	0.57	S.
,,	,,	,,	During and After	=	0.13	N.S.
Lower:	,,	,,	Before and During	=	0.52	S.
,,	,,	,,	During and After	=	0.20	N.S.

TABLE C

ARCH BREADTH

Inter- and Extra-Canine

	NO.		
Upper Inter Canine	61	0.41	
,, Extra Canine	61	0.50	
Difference		0.09	N.S.
Lower Inter Canine	59	0.33	
,, Extra Canine	59	0.54	
Difference		0.21	S

INCREASE PER 10 MONTHS

TABLE D

DISTANCE BETWEEN MEDIAL C TO DISTAL E

(*upper and lower*)

DECREASE PER 10 MONTHS

	NO.		
$\underline{C}$ Right	55	— 0.12	
$\overline{C}$ Right	56	— 0.16	
Difference		0.04	N.S.

	NO.		
$\underline{C}$ Left	55	— 0.11	
$\overline{C}$ Left	56	— 0.20	
Difference		0.09	S

The distances between the medial surfaces of the deciduous canines and the distal surfaces of the second deciduous molars.

TABLE D On the right side there was an average decrease in the upper arch and in the lower, the difference between the two not being significant. This however, showed that the closure of space in this region after the eruption of the first permanent molars was only 0.20 mm. greater in the lower than in the upper. On the left there was a decrease in the upper arch and in the lower the difference being statistically significant. But even in this region the lower space closure was only 0.45 mm. greater than in the upper. Table D shows the comparison between the upper and lower on each side.

After complete eruption of the deciduous teeth considerable variation in the size of

the arches was found. They varied from cases with spaces between all the teeth to cases with no spaces. There was no visible increase in inter-dental spacing in those arches with separated teeth at 3 years of age but the statistics show that there was a slight increase in the inter-canine breadth in the upper and in the lower before the eruption of the permanent teeth, which indicates that a very slight increase of spacing between the canines and incisors must have occurred. The main increases in arch breadth and length took place during the eruption of the permanent incisors as described by Baume and only slight increases were recorded over the rest of the period examined. Baume describes two distinct types of arrangement of the deciduous teeth, spaced or closed. But the spaced arches vary so considerably that there appears to be a greater difference between, for instance, a case with spacing between all the teeth and a case where the spacing in both arches total 1.00 mm., than between the latter and a case with no spacing at all. The distribution of spaces showed every possible variation, a spaced arch even being combined with a closed. Spaced incisors and canines were more common in the upper arch, and spaced canines and first molars in the lower. This made it difficult to assess the exact changes in arch relationship except in each individual case. The statistics however, show definite indications of the basic changes which occurred.

The anteroposterior distance between the distal surfaces of the upper second deciduous molars and the medial surfaces of the lower canines.

TABLE E. On the right and left this showed a significant decrease. As the commonest area for spacing in the lower arch is between the canine and first deciduous molar this reducing measurement would indicate that the lower canine was moving distally.

The anteroposterior distance between the distal surfaces of the upper canines and the medial surfaces of the lower canines.

TABLE F. On the right and left this showed a significant increase. It is difficult to reconcile a *reduction* in space between $\underline{E}$ and $\overline{C}$ and an increase in space between $\underline{C}$ and $\overline{C}$, and I can only make a tentative suggestion that the upper canine moves distally more than the lower. This would allow more space for the accommodation of the larger upper permanent incisors. This however, is only a suggestion and needs further investigation.

TABLE E

ANTERO-POSTERIOR DISTANCE BETWEEN $\underline{E}$ AND $\overline{C}$

	NO.		
Right	51	— 0.14 S	DECREASE PER 10 MONTHS
Left	51	— 0.12 S	

TABLE F

ANTERO-POSTERIOR DISTANCE BETWEEN $\underline{C}$ AND $\overline{C}$

	NO.		
Right	58	0.09 S	INCREASE PER 10 MONTHS
Left	58	0.12 S	

TABLE G

ANTERO-POSTERIOR DISTANCE BETWEEN $\underline{E}$ AND $\overline{E}$

MEAN INCREASE PER 10 MONTHS

	NO.	Up to 4y. 6m.	NO.	4y. 6m.—5y. 5m.	NO.	5y. 6m. +
Right	54	0.49 mm.	45	0.15 mm.	48	0.25 mm.
Left	55	0.40 mm.	44	0.28 mm.	49	0.29 mm.
		1		**2**		**3**

Right:	Difference Between	**1** and **2**	= 0.34	S	PER 10 MONTHS
	,, ,,	**2** and **3**	= 0.10	N.S.	
Left:	Difference Between	**1** and **2**	= 0.12	S	
	,, ,,	**2** and **3**	= 0.01	N.S.	

The anteroposterior distance between the distal surfaces of the upper and lower second deciduous molars.

On the right and left this showed a significant increase. Table G shows the amount of movement per ten months taking place during three stages of the development and the difference between them.

THE DEVELOPMENT OF NORMAL OCCLUSION

During the development of normal occlusion space for the permanent incisors is obtained in the upper arch by the spacing in the deciduous arch, by expansion of the arch chiefly during the eruption of the permanent incisors and by the increased labial inclination of the permanent incisors as compared to the deciduous. In the lower it is obtained by the spacing in the decid-

A

B

C

D

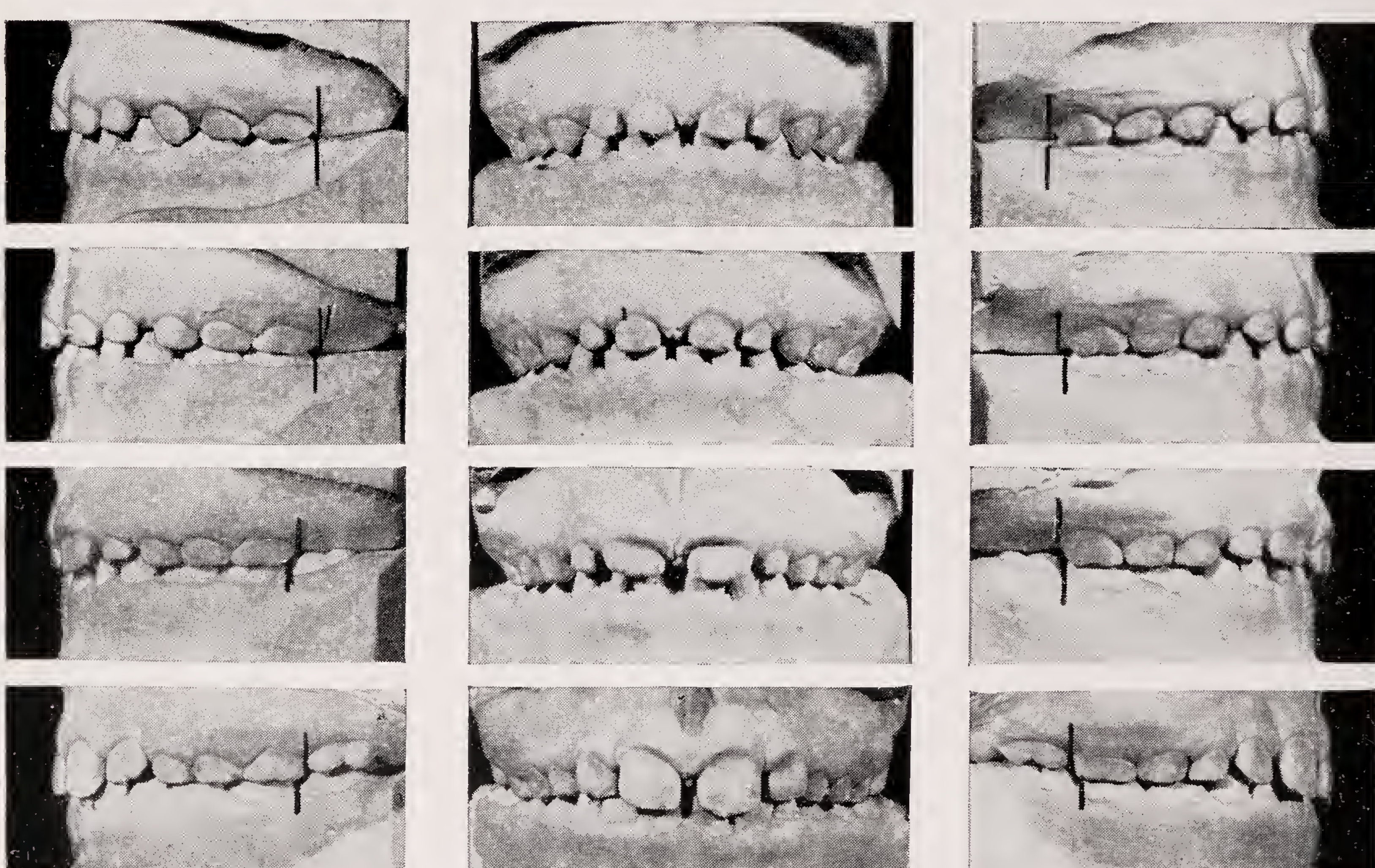


FIGURE 2.

A. 4 *years.* *B.* 5 *years.* *C.* 6 *years* 2 *months.* *D.* 7 *years* 2 *months.*
Showing four stages in the development of normal occlusion

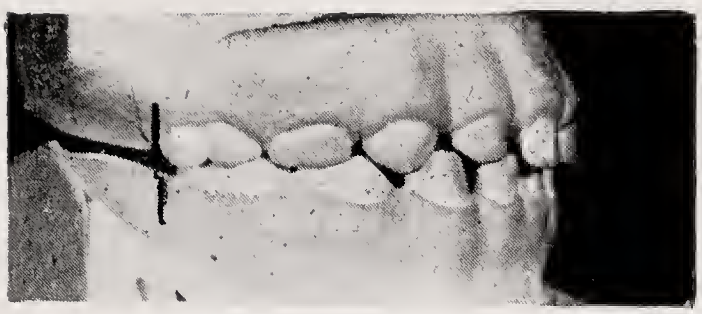


Fig. 3. A.

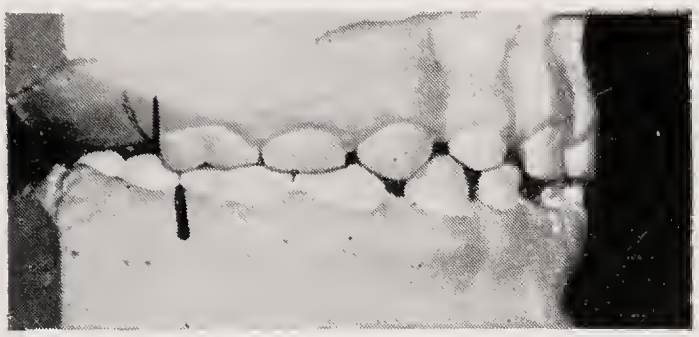


Fig. 3. B.

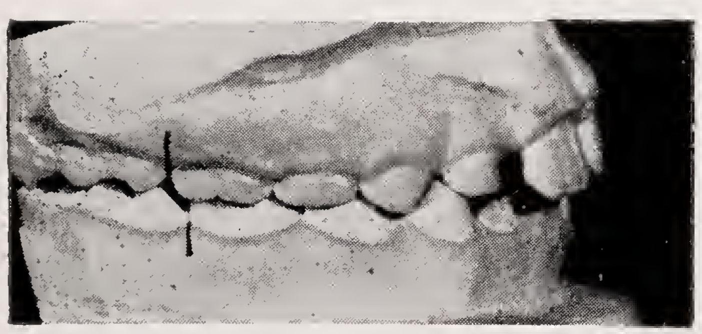


Fig. 3. C.

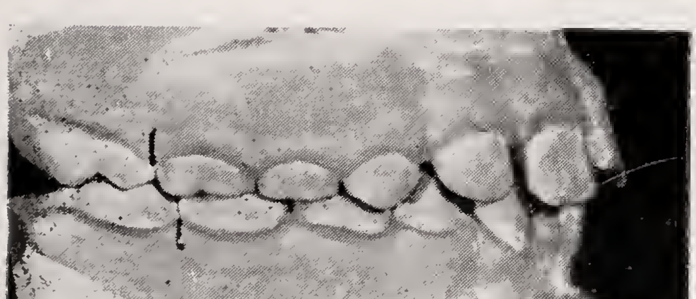


Fig. 3. D.

FIG. 3. Case 34.

A. 4 years. B. 5 years 2 months. C. 6 years 5 months. D. 7 years 6 months. Between A and B the distal surface of the lower second deciduous molar has moved in relation to the upper but the space between $\overline{C|}$ *and* $\overline{D|}$ *has not changed.*

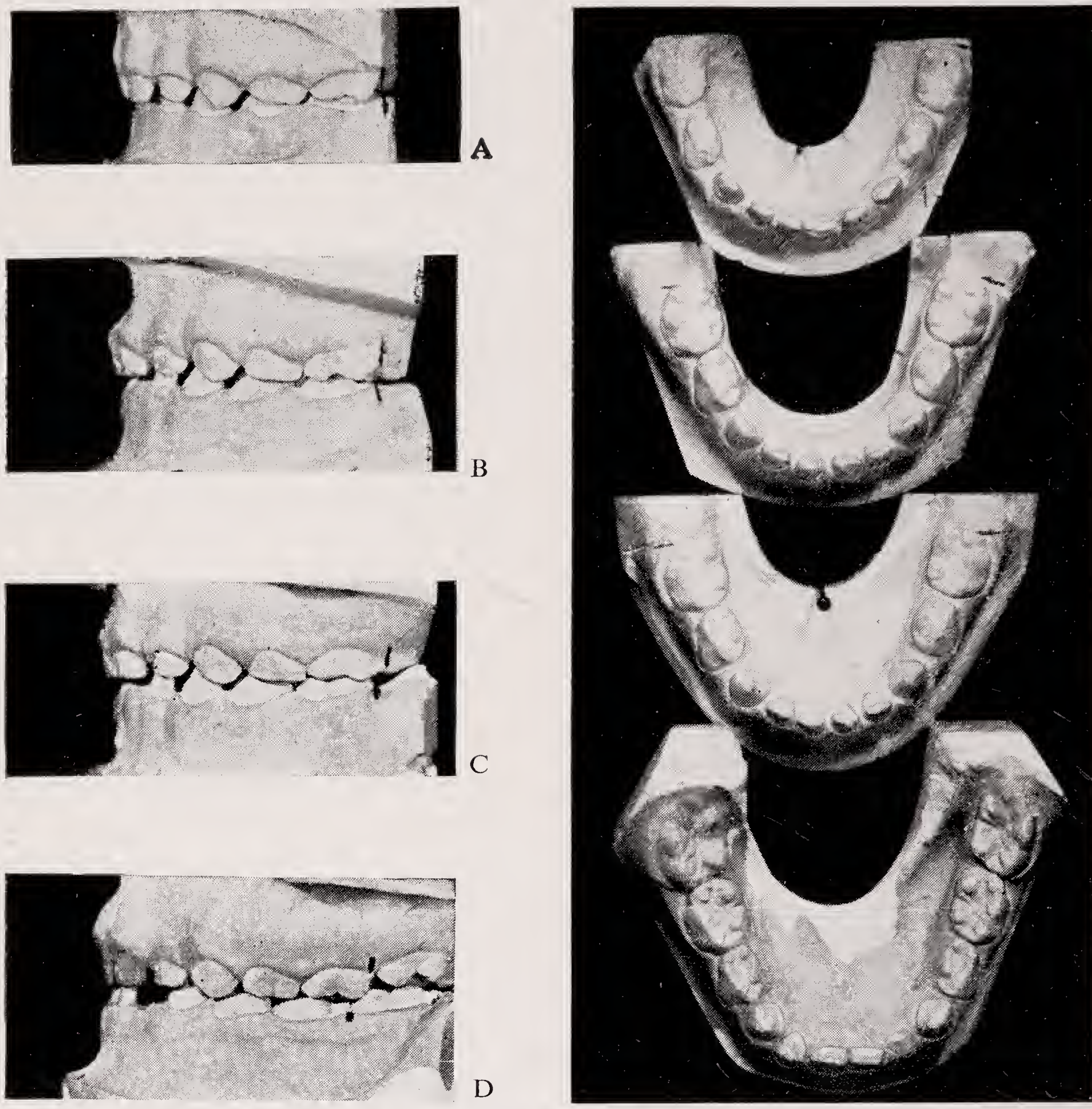
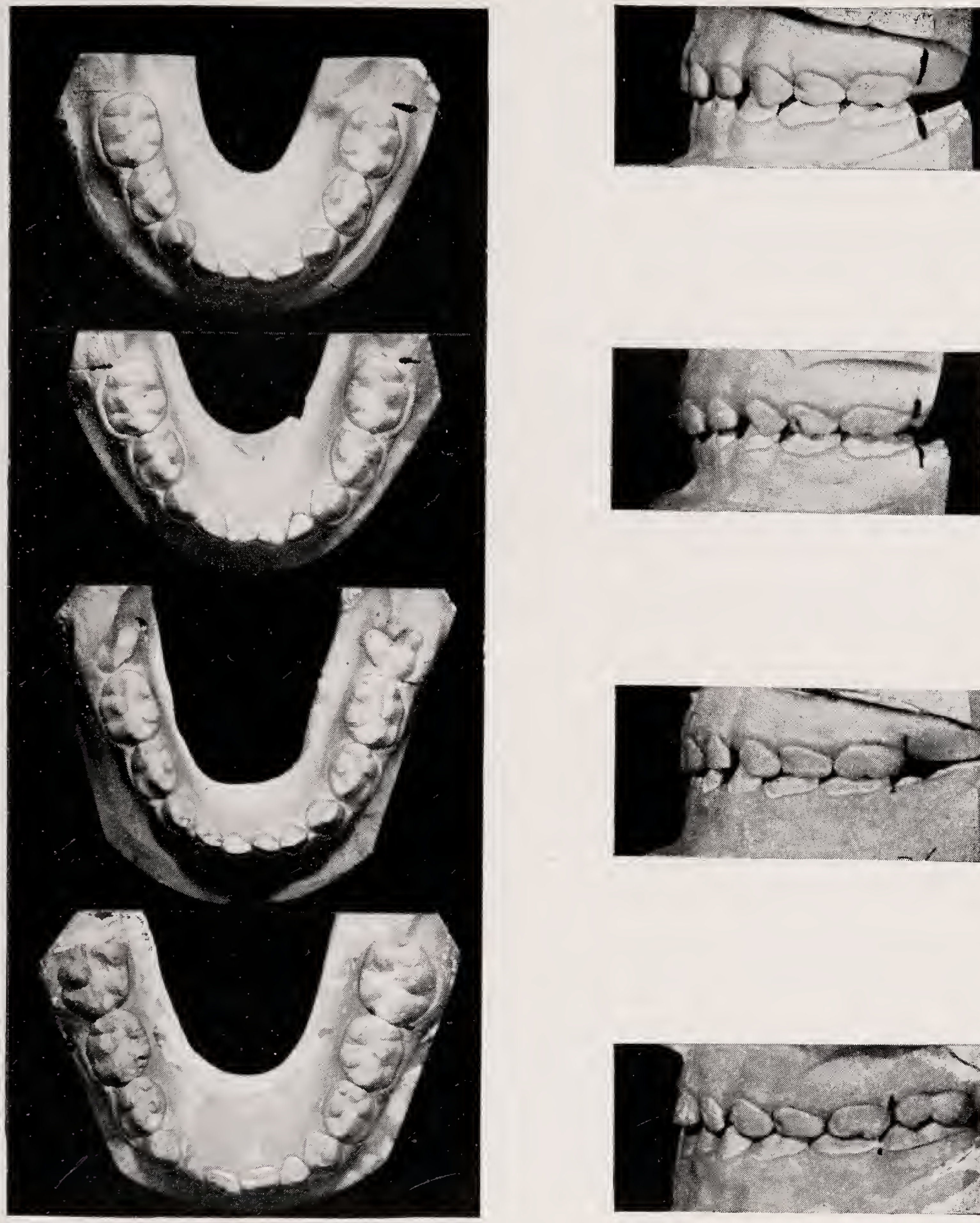


FIGURE 4

Case 50. A, 3 years 6 months. B, 4 years 6 months. C, 5 years 7 months. D, 6 years 7 months. The distal surface of the lower second deciduous molars has moved forward in relation to the upper but the space between $\overline{|C}$ and $\overline{|D}$ is unchanged in A, B & C.

uous arch and by expansion chiefly during the eruption of the permanent incisors. Some space is also obtained through the tilting of the canines as the extra-canine breadth showed a small but significant increase over the inter-canine breadth.

The changes which occur during the development of normal arch relationship follow the description given by Friel. The distal surfaces of the second deciduous molars are flush at three years of age. In order to allow the permanent molars to erupt into normal occlusion the lower deciduous molars move forward in relation to the uppers. Baume claims that this is done through the closure of the space between the lower canine and first deciduous molar. It can be shown however, that the molar relationship changes without a reduction in the size of this space. *Fig.* 3, 4, & 5. In addition the largest space in this area in the present material was 1.70 mm. whereas according to the measurements described the distal surfaces of the lower second deciduous molars move forward an average of approximately 2.60



A

B

C

D

FIGURE 5.

Case 36. A, 3 years 4 months. B, 4 years 3 months. C, 5 years 4 months. D, 6 years 5 months. Showing the forward movement of the lower deciduous molar in relation to the upper without change in the space between |C and |D In A, B and C.

mm. in relation to the upper.

Incidence of Malocclusion. When the deciduous dentition was complete out of 61 cases only 26 had normal occlusion. It was obvious that many of these abnormalities must improve as an incidence of over 57% is fortunately not found in the permanent dentition. By the end of the period investigated the percentage was reduced to 28 which was still high. This however included irregularities due to caries and extractions and there were

A

B

C

D

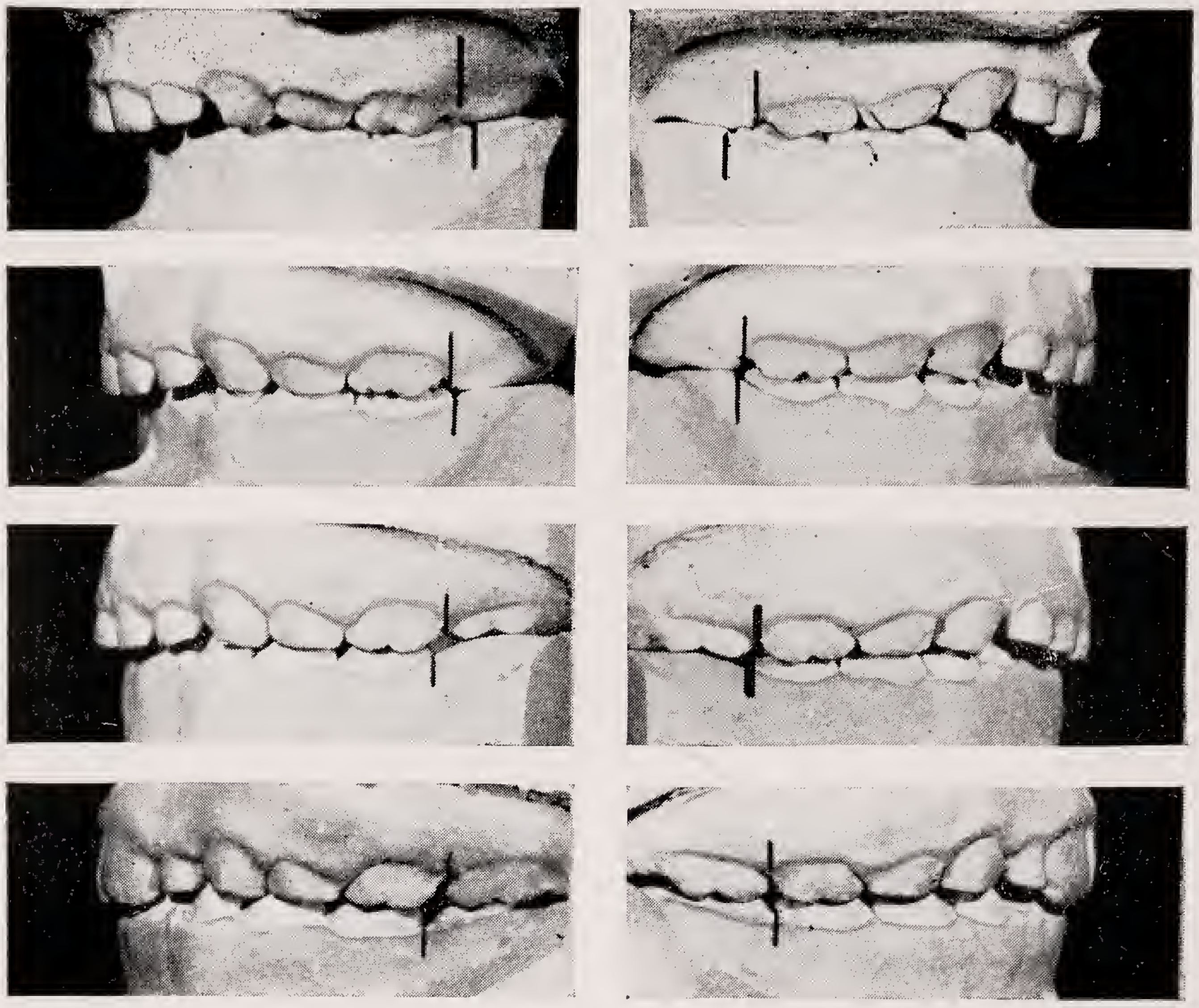


FIGURE 6.

Case 48. *A*, 3 *years* 4 *months*. *B*, 4 *years* 5 *months*. *C*, 5 *years* 6 *months*. *D*, 6 *years* 6 *months*. *Postnormal relationship of the lower arch to the upper in A. As the condition improves the first permanent molars are in normal occlusion on the left side in D. and the lower is slightly postnormal on the right. The forward movement of* $\overline{|E}$ *in relation to* $\underline{|E}$ *is* 2.50 *mm., and of* $E|$ *to* $\underline{E|}$ *it is* 2.60 *mm.*

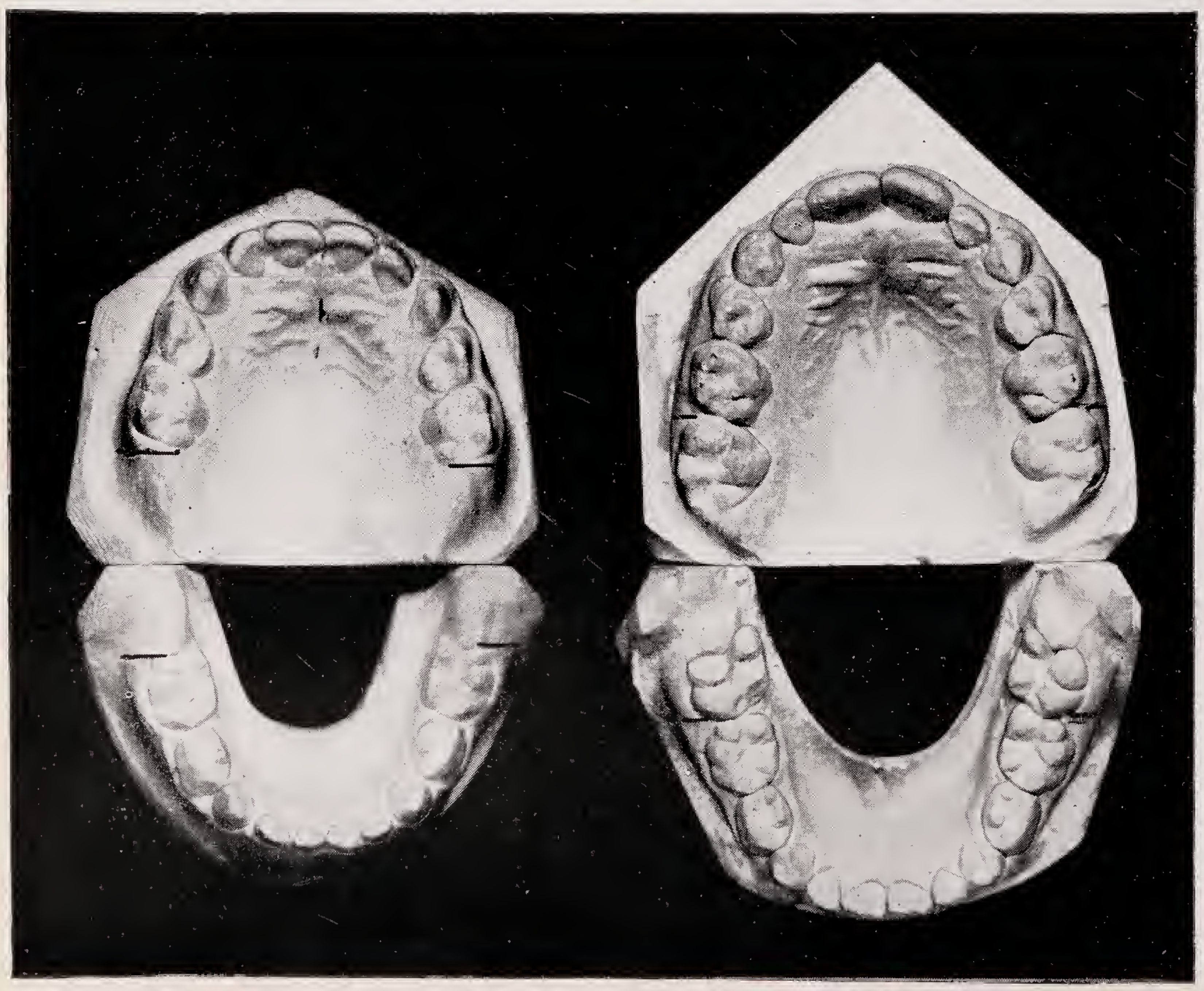


FIG. 7.
Case 48.
Occlusal views of A and D.

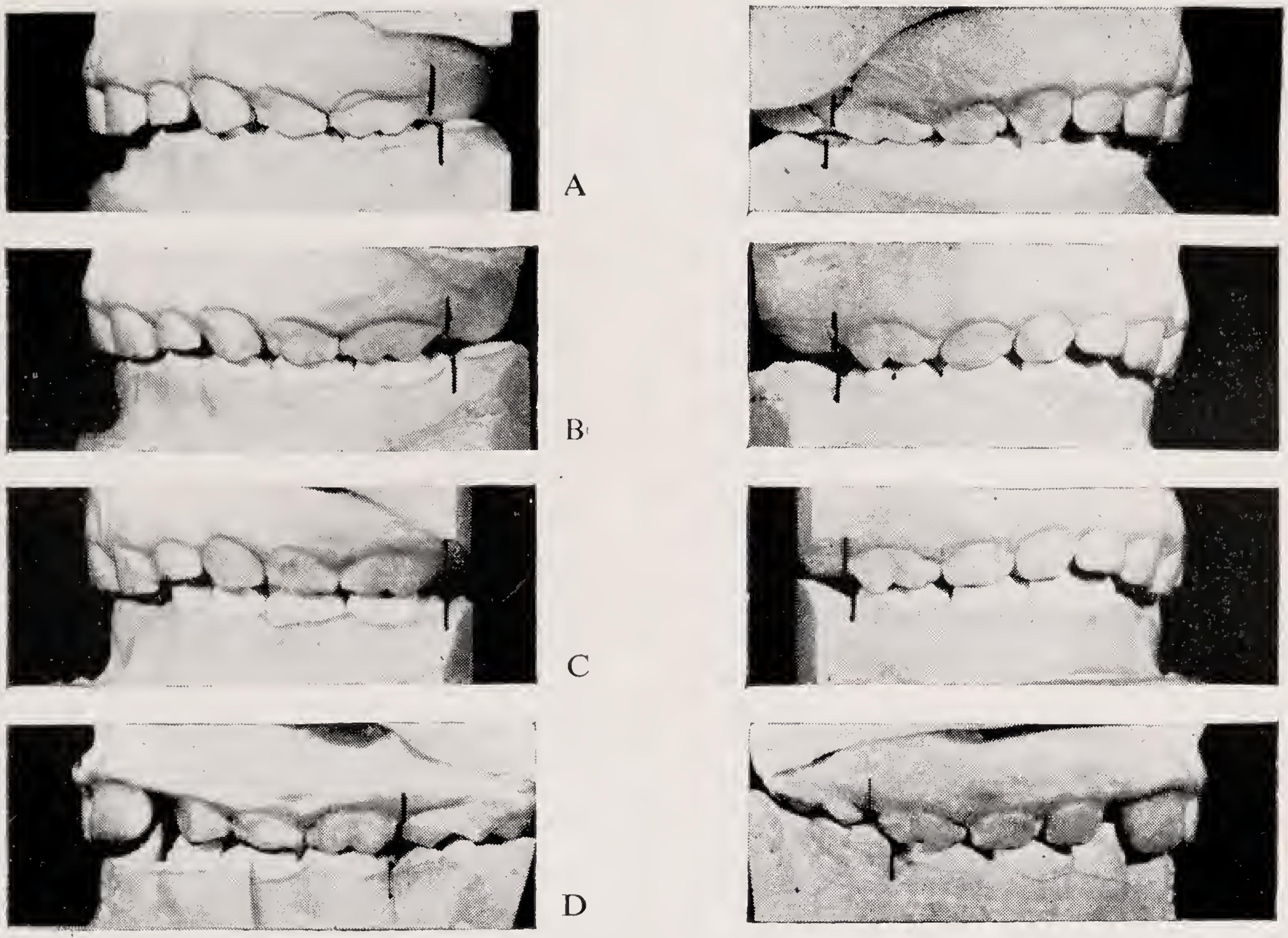


FIGURE 8
Case 46. *A*, 3 *years* 4 *months. B*, 4 *years* 5 *months. C*, 5 *years* 5 *months. D*, 6 *years* 6 *months. Showing forward movement of lower arch in relation to upper.*

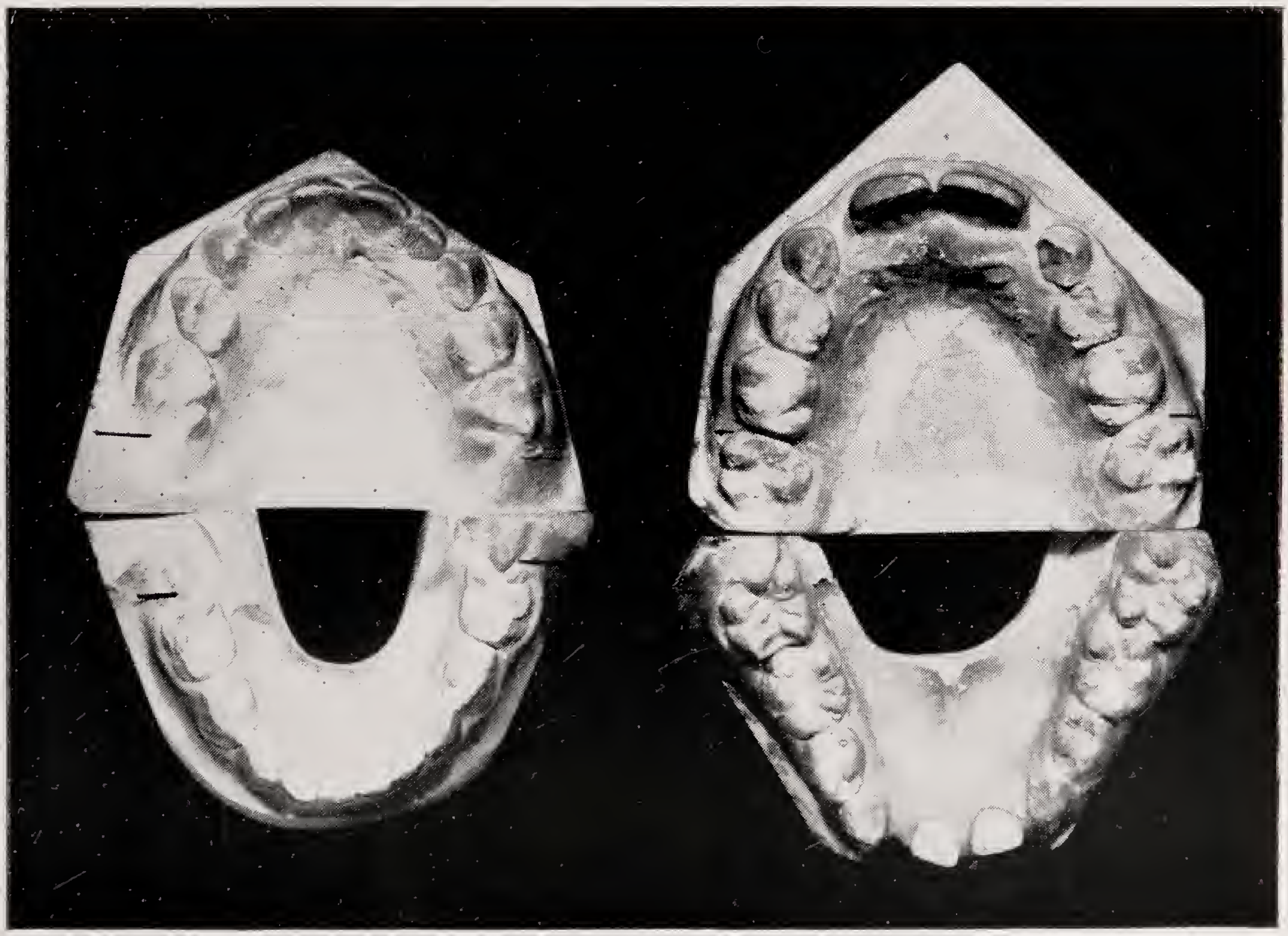


FIGURE 9.
Case 46. *Occlusal views of A and D. No spacing in A. Subnormal arches in D.*

A

B

C

D

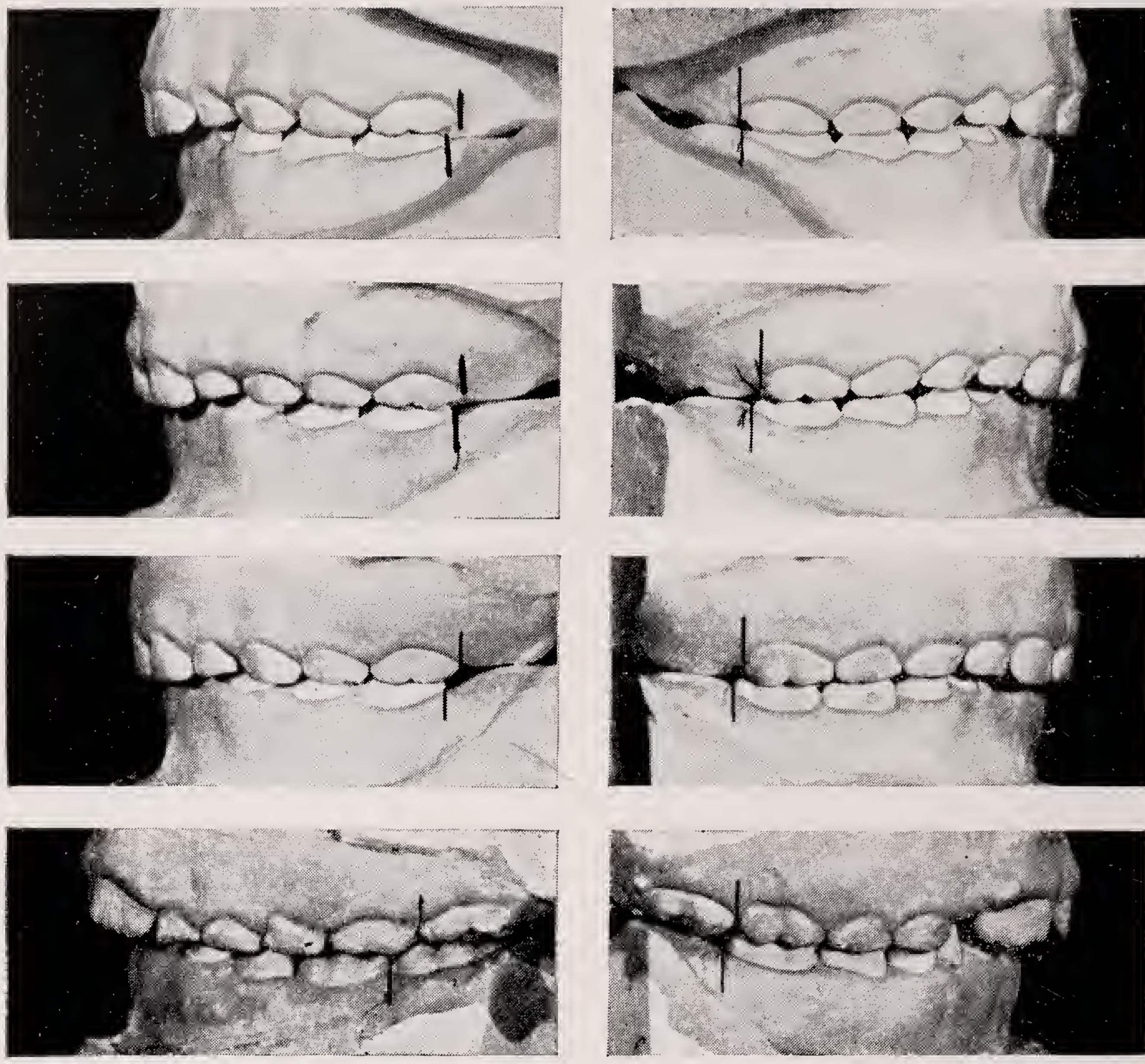


FIGURE 10.

Case 5. *A*, 3 *years* 11 *months*. *B*, 4 *years* 11 *months*. *C*, 6 *years*. *D*, 7 *years* *Unilateral postnormal occlusion of lower arch on right side. Normal molar occlusion on left.*

indications that when the deciduous molars were shed and the premolars erupted the number would be reduced further.

Types of Malocclusion. In the early stage there were 19 cases of postnormal relationship of the lower arch to the upper, *i.e.*, the distal surfaces of the *lower* second deciduous molars were posterior to the *upper* second deciduous molars. In seven of these cases the first permanent molars erupted into normal occlusion and six of these had sucking habits which stopped early. In one case there was slight unilateral postnormal occlusion at 6 years 6 months. *Fig*. 6 & 7. Of four cases of prenormal relationship of the lower arch to the upper one became normal. And of 12 cases of subnormal or malformed arches seven became normal. Under the heading subnormal arches were included those cases showing no spaces even though some had no imbrication until the eruption of the permanent incisors, because it was found that if no spaces were present in the deciduous dentition there was imbrication in the permanent dentition. *Figs* 8, 9, 10 *and* 11.

Habits. Eighteen of the children between three and four years of age sucked either a thumb or one or two fingers and all of these had malformations. Ten had postnormal lower arches, and six of these who stopped the habit early became normal, one became normal despite persisting in the habit. Two had prenormal relationship of the lower arch and one of these became normal although both stopped the habit at about five years of age. Four had normal arch relationship but malformed arches,

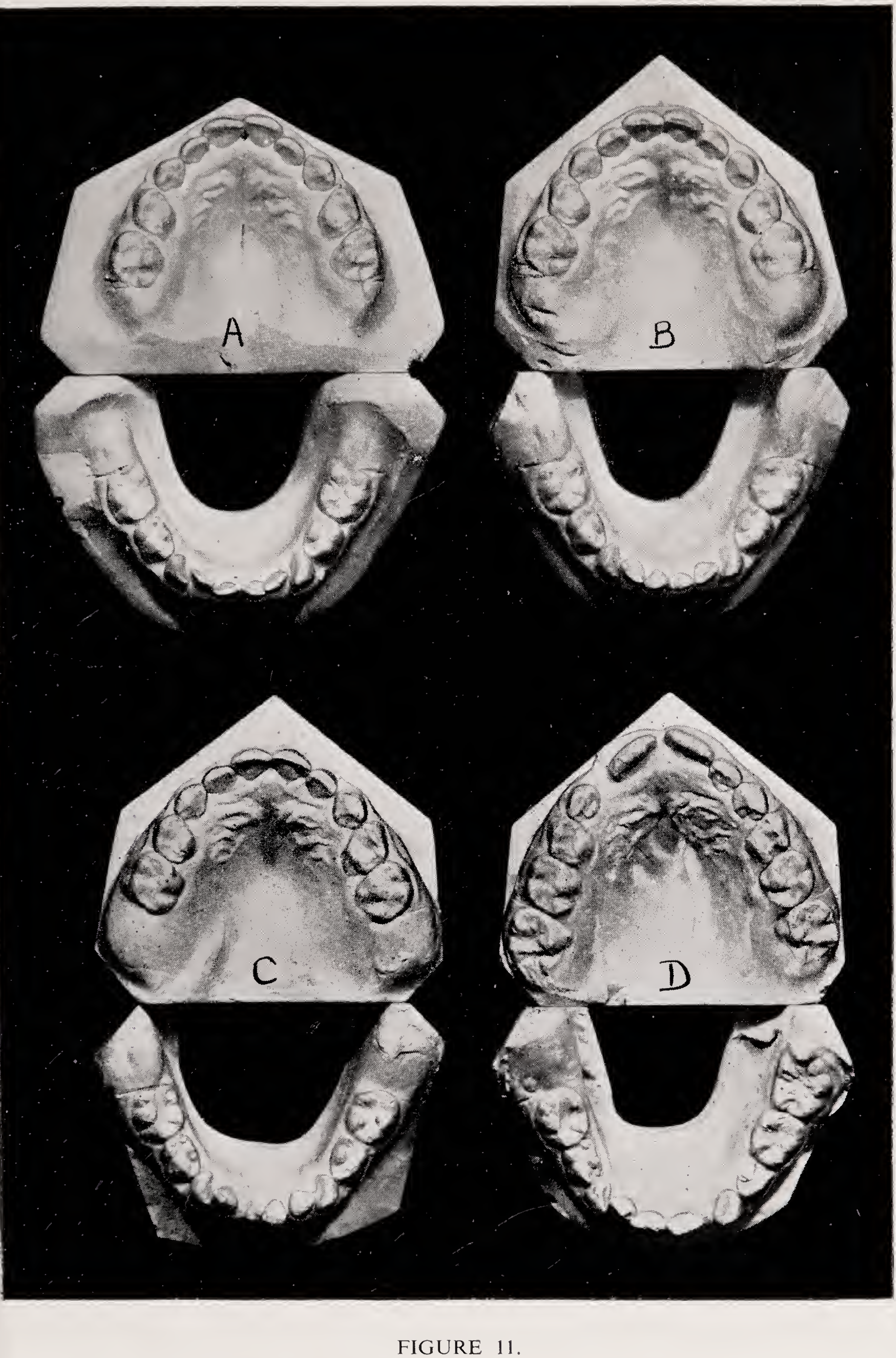
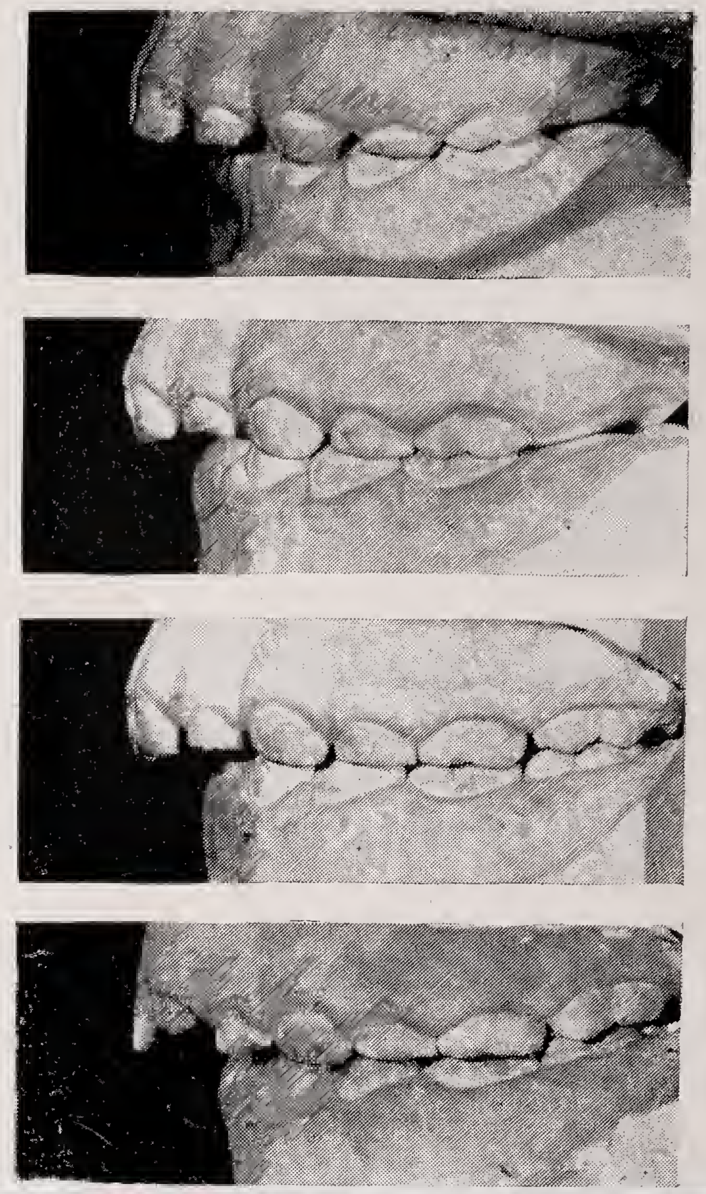


FIGURE 11.

Case 5. Occlusal views showing imbrication in incisor areas persisting throughout.

two of these who stopped the habit before 5 years of age became normal and one became normal despite persisting in the habit. *Figs.* 12 *and* 13.

Premature loss of deciduous teeth. Ten cases had a tooth or teeth extracted prematurely during the period investigated; in every case in which a deciduous molar was removed prematurely there was loss of space and this was greater in subnormal



A

B

C

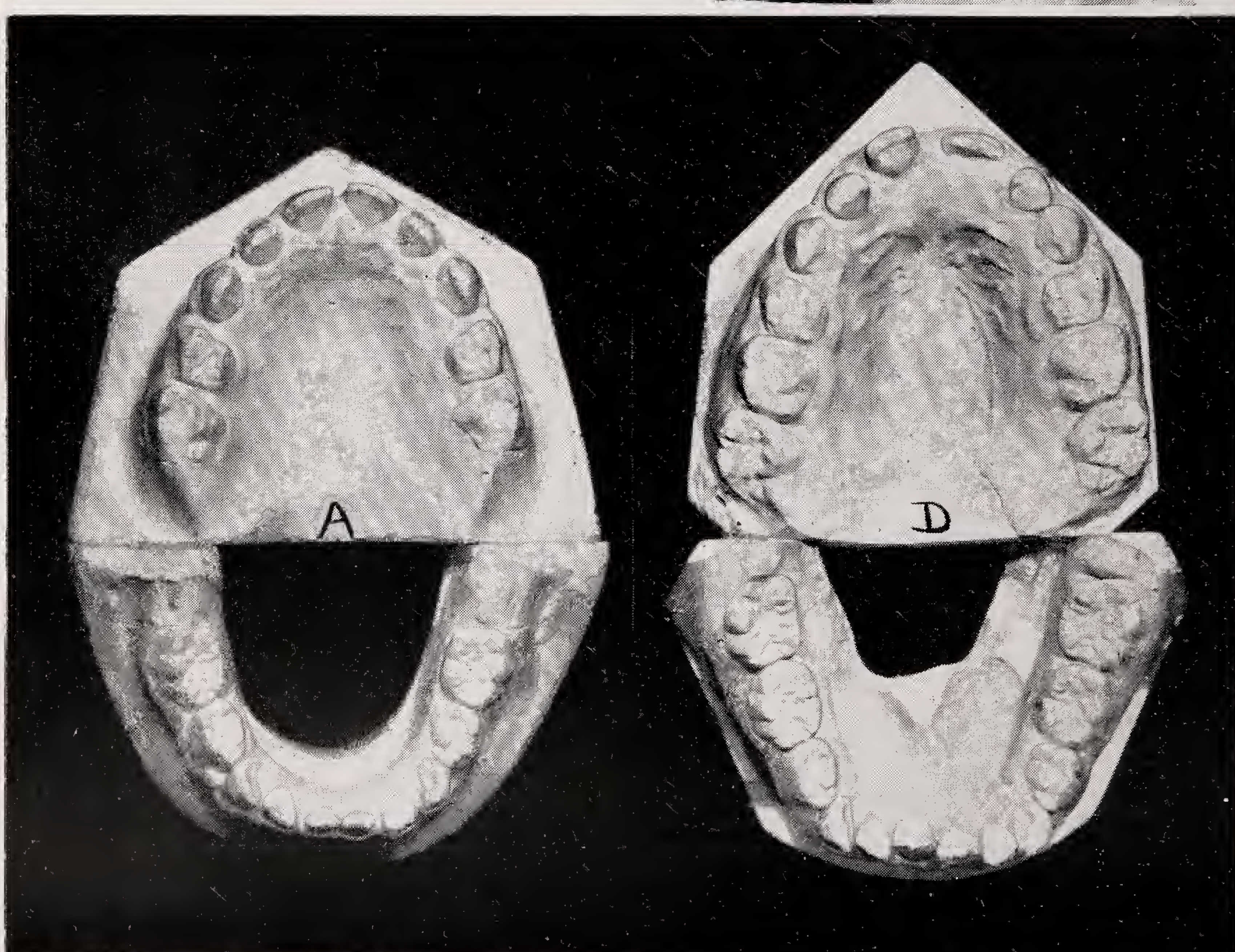
D

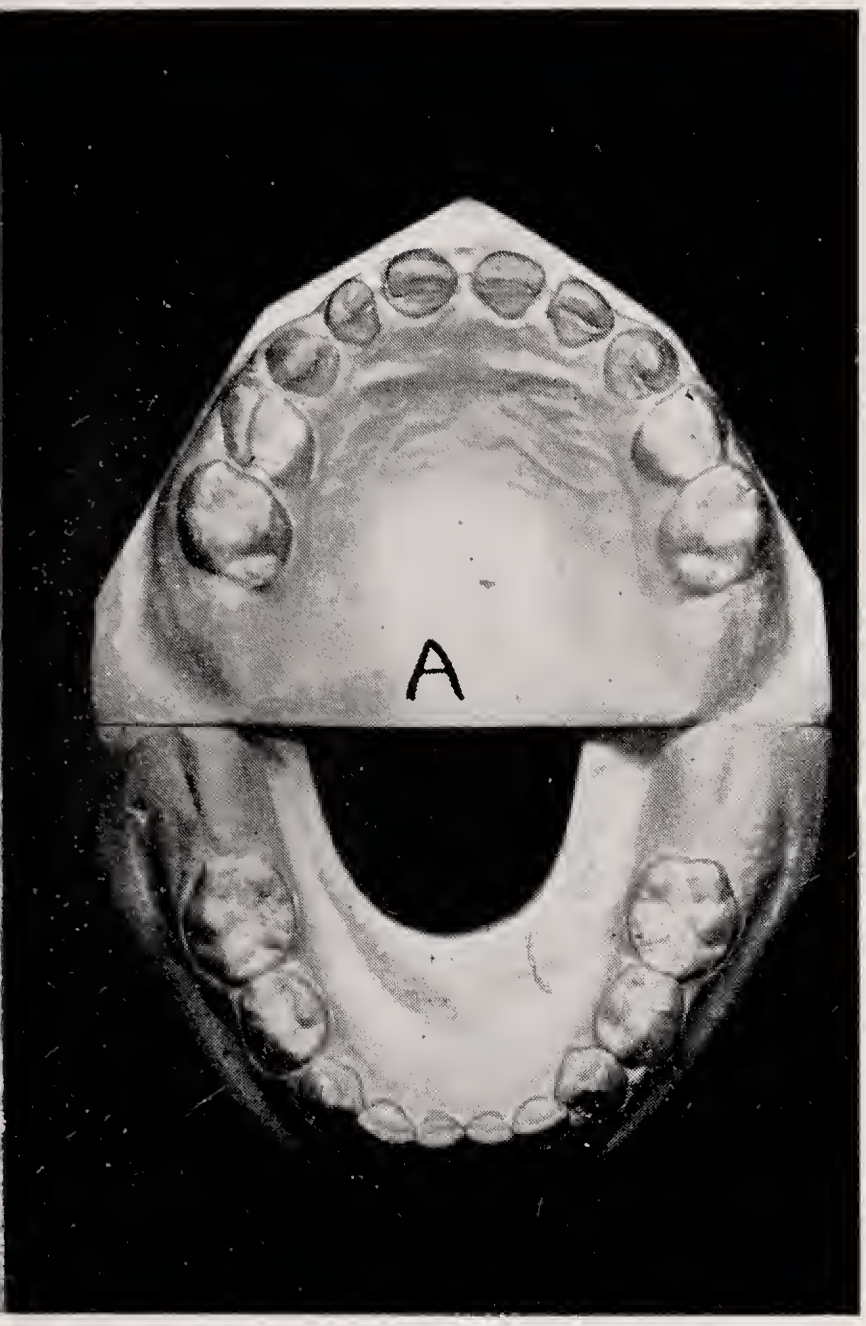
FIGURE 12

Case 54. *A*, 3 *years* 3 *months. B*, 4 *years* 4 *months. C*, 5 *years* 6 *months. D*, 6 *years* 6 *months. Sucks two fingers of left hand, habit persisted throughout. Normal molar relationship with prenormal premaxillae and subnormal lower incisor area.*

FIGURE 13

Case 54. *Occlusal views of A and D.*





arches. The reduction in space was greater in the upper than in the lower and greatest when the extractions were done before the eruption of the first permanent molars. *Fig.* 14, 15, 16, and 17.

It has been mentioned already that there were indications how the percentage of malocclusion would continue to decrease. It is possible that one method is by the opening of spaces which had partially closed after extractions. *Fig.* 18.

In this case the upper left first deciduous molar was extracted at six years three months. The series of models show the following changes. At four years the width of the first molar was 7.3 mm., at five years

FIGURE 14

Case 30. *Occlusal views.*

A. 4 *years* 10 *months.*

$\frac{D \mid D}{\mid E}$ *extracted at* 5 *years* 6 *months.*

B. 6 *years* 2 *months.*

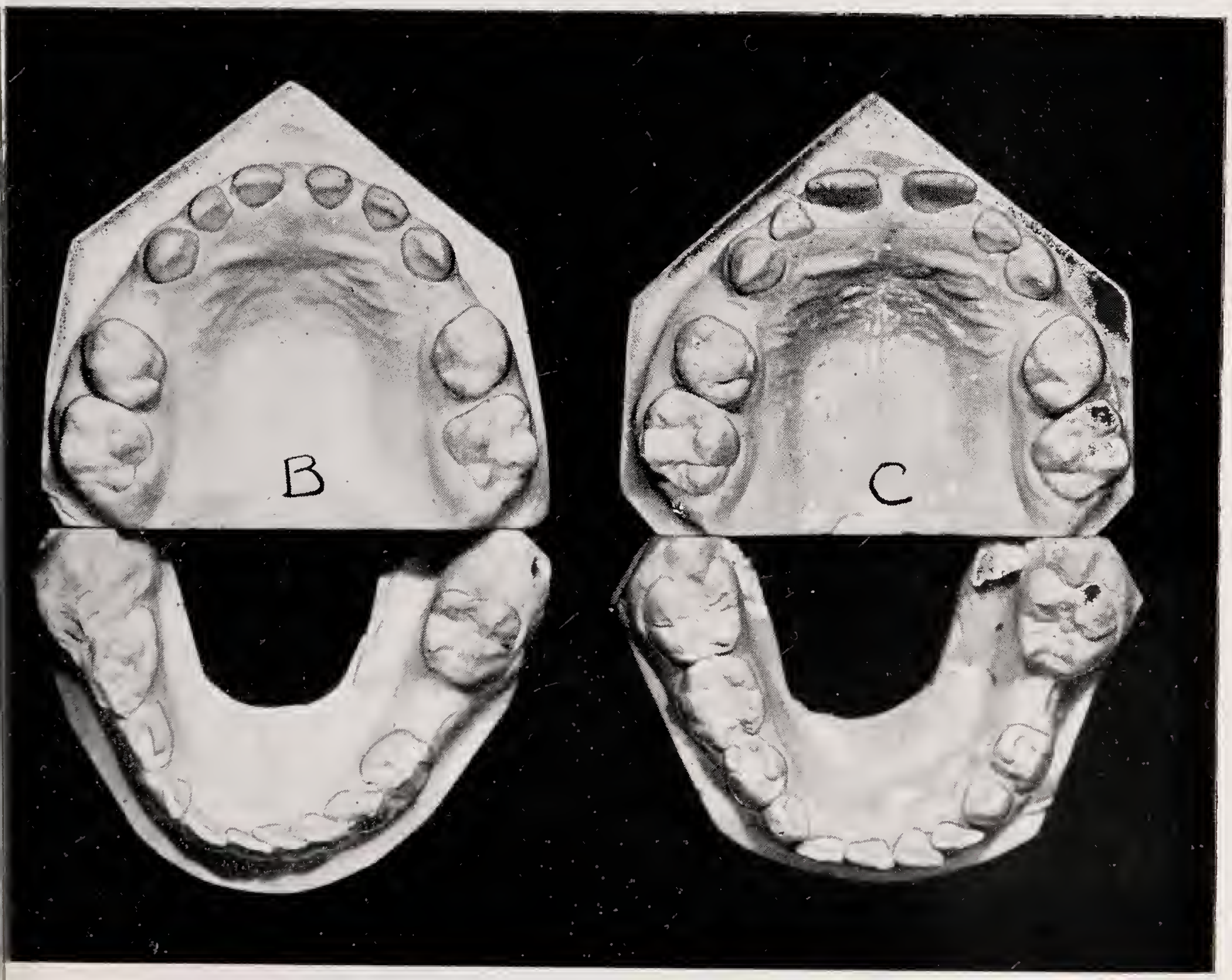
$\underline{D \mid D}$ *spaces closed* 2.80 *mm.*

$\mid E$ *space closed* 3.50 *mm.*

C. 7 *years* 2 *months.*

$\underline{D \mid D}$ *spaces closed* 4.10 *mm.*

$\mid E$ *space closed* 4.00 *mm.*



A

B

C

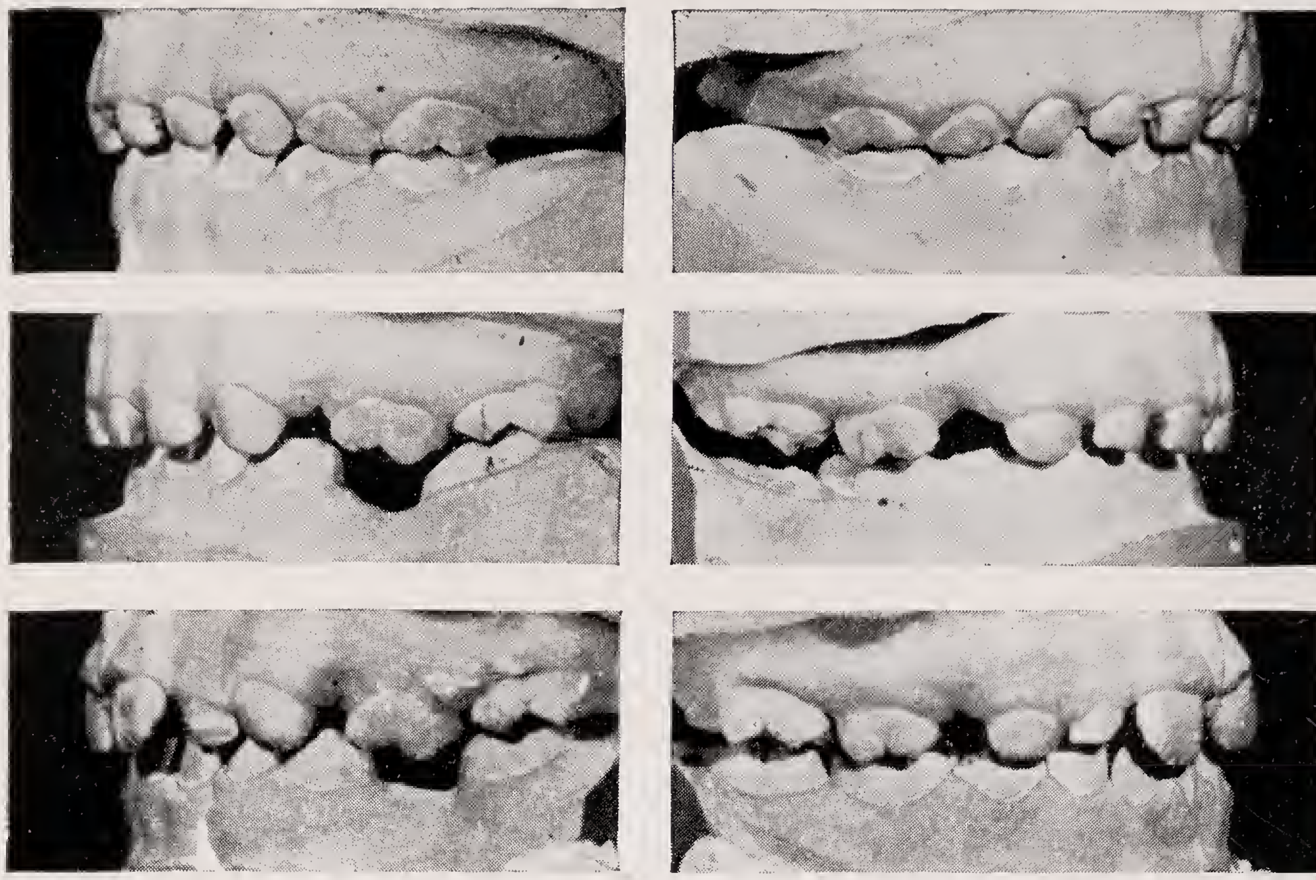


FIGURE 15

Case 30. *Left and right sides.*

FIG. 16

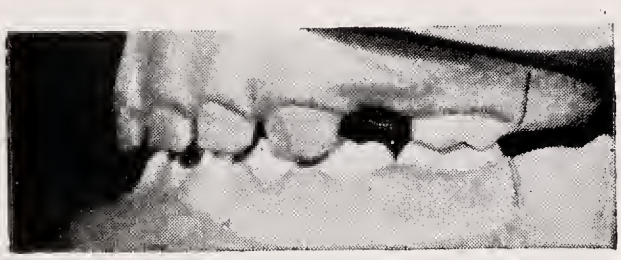
Case 32.

D | D extracted at 3 *years* 2 *months.*

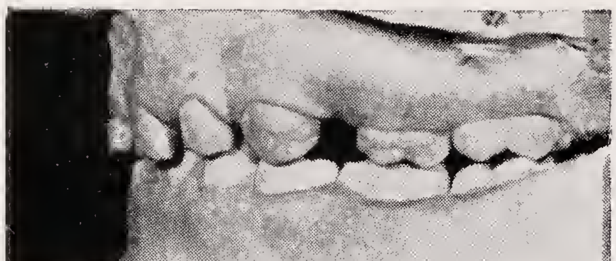
A. 4 *years. D | D spaces are* 5.00 *mms.*

B. 5 *years* 6 *months. D | D spaces are* 2.00 *mms.*

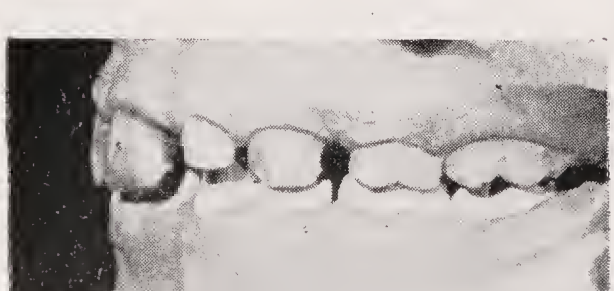
C. 6 *years* 6 *months. D | D spaces are* 1.50 *mms.*



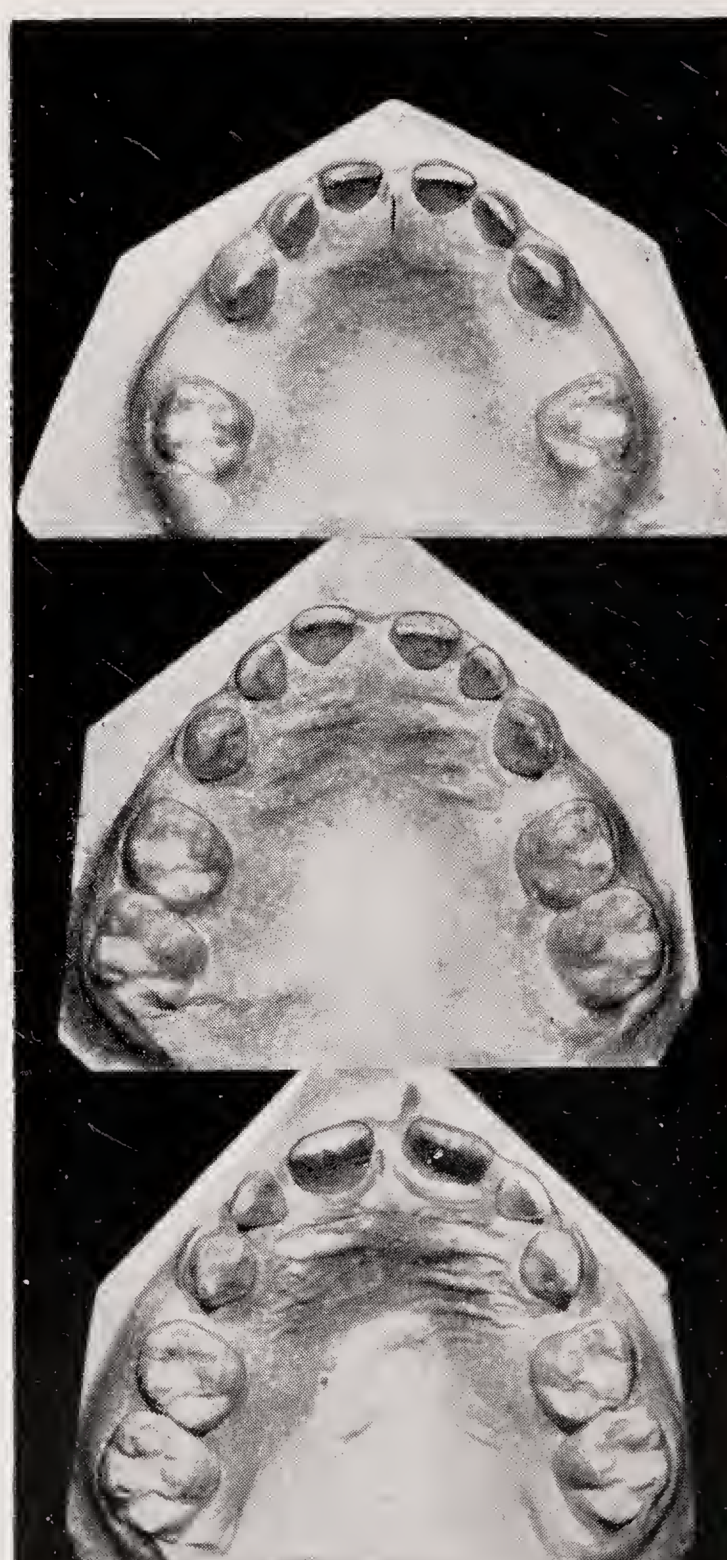
A



B



C



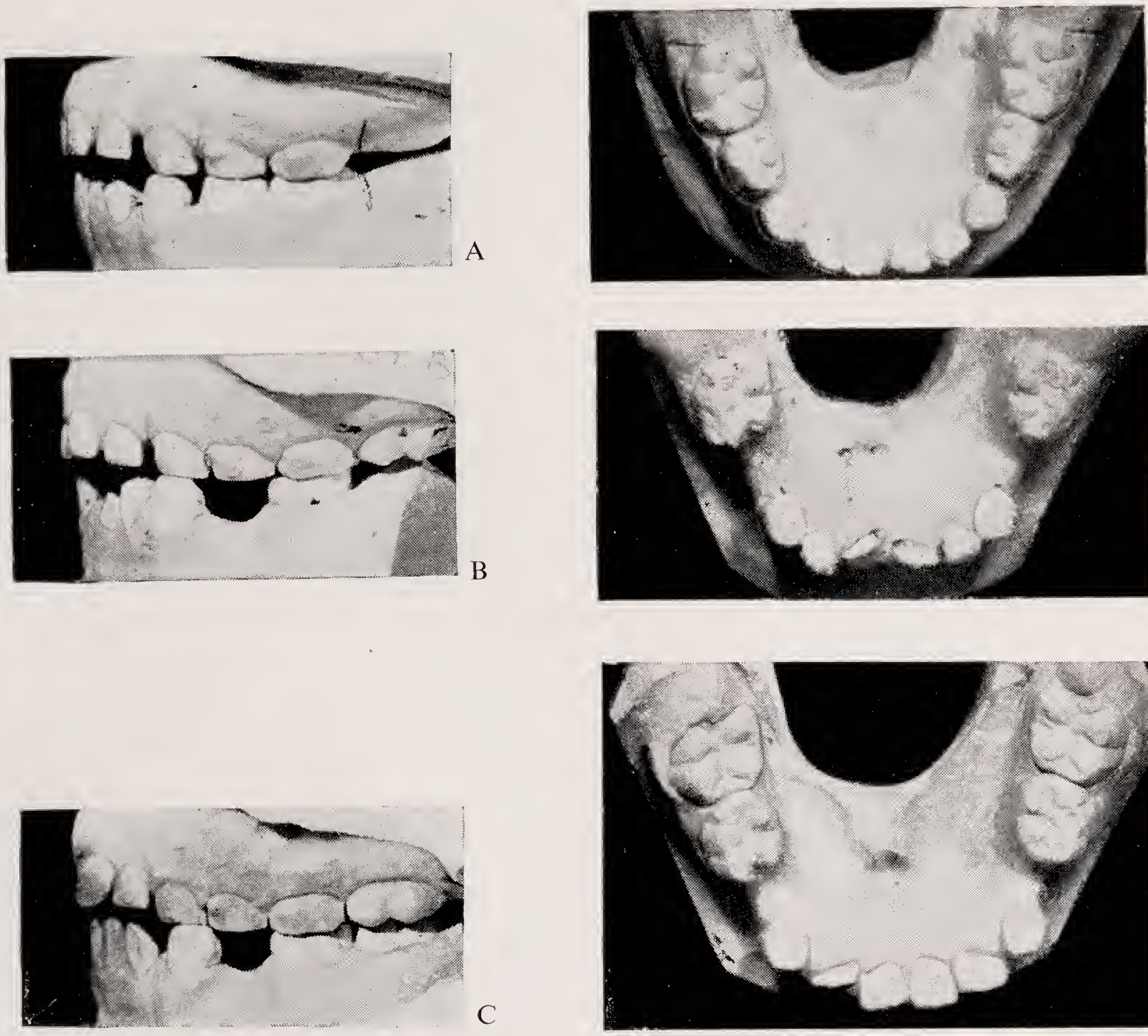


FIGURE 17

Case 66. *A,* 5 *years. B,* 6 *years* 1 *month. C,* 7 *years* 3 *months. D | D extracted at* 5 *years* 10 *months. B. D | D spaces closed* 2.00 *mm. C,* $\overline{D \mid D}$ *spaces closed* 2.90 *mm.*

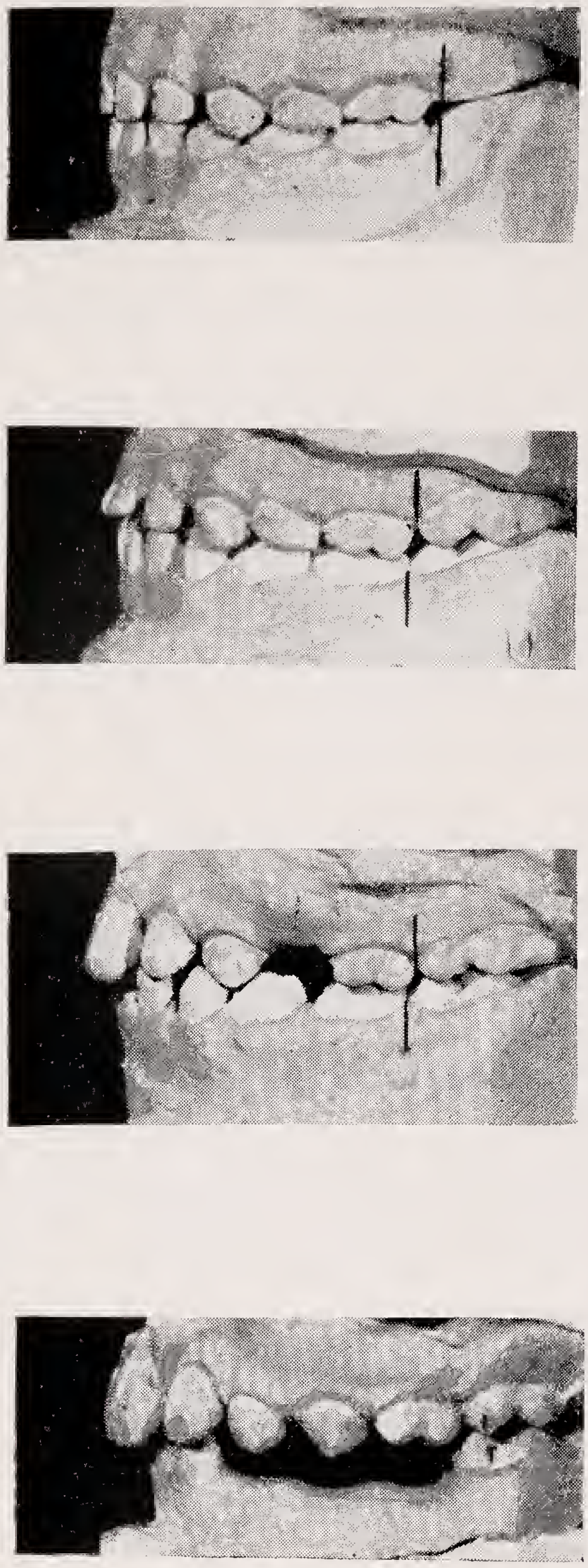
six months it was reduced by caries to 7.0 mm. At six years nine months (six months after the extraction of the tooth) the space was 6.2 mm. But at eight years after the eruption of the first premolar the space had opened to 8 mm. Another method is that in some cases the antero-posterior width of the lower 2nd deciduous molar is larger in proportion to the upper than the average, and the lower permanent molar does not come into normal occlusion until the deciduous molar is shed.

GENERAL HEALTH AND MALOCCLUSION

Details of general health from birth were recorded but no definite correlation could be found between any forms of malocclusion and the common diseases of infancy and childhood. It was observed however that the tendency to caries increased rapidly in some individuals after the fevers and thus increased the local conditions giving rise to malocclusions. This may have been due to lowering of resistance but it was noticed that oral hygiene was frequently neglected during these illnesses and this may also have caused the tendency. The numbers under observation however, were too small to show more than an indication in this direction.

CONDITION DURING PREGNANCY

Forty-two mothers had normal pregnancies throughout and of these twenty-



A

B

C

D

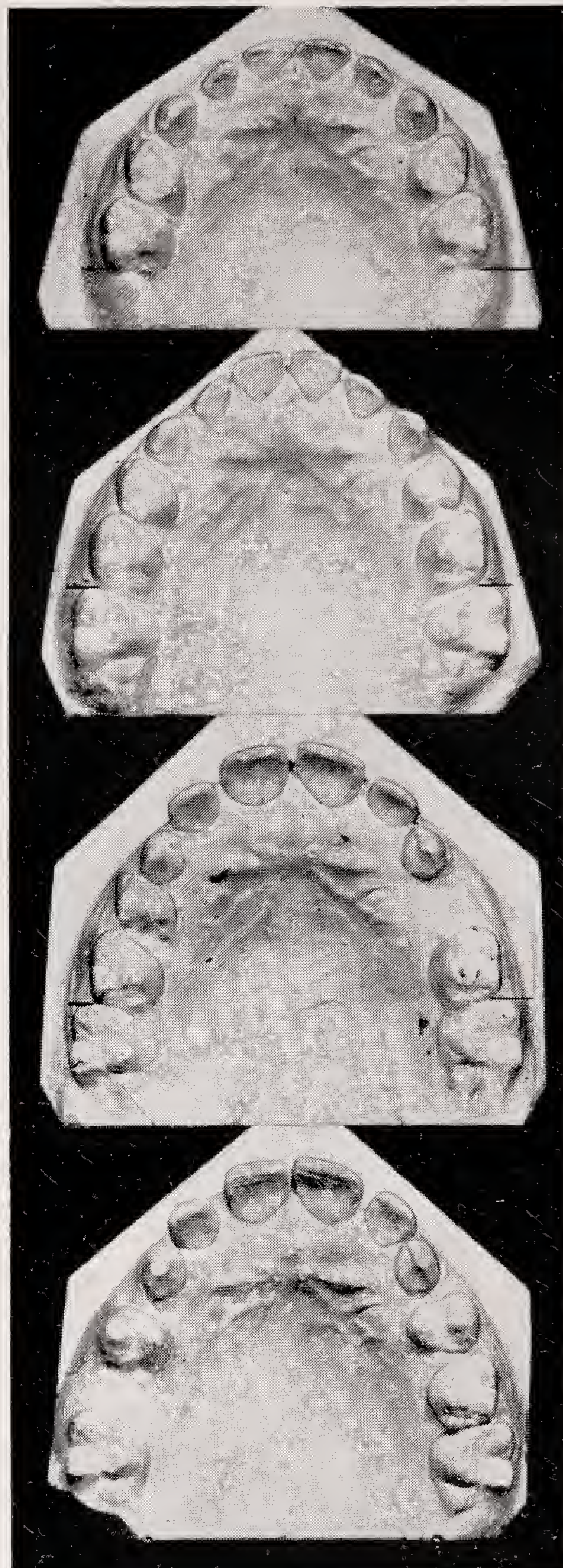


FIGURE 18

Case 28. A, 4 years. B, 5 years 6 months. C, 6 years 9 months. D, 8 years. In A, width of |D =7.30 *mms. B. width of* |D =7.00 *mms.* (*caries*). |D *extracted at* 6 *years* 3 *months. C, width of space*=6.20 *mms. D, width of space*=8.00 *mms.*

one had children with normal occlusion at three to four years of age. Nineteen mothers had illnesses of various kinds during pregnancy and of these seven had children with normal occlusion at three to four years. There appeared to be no correlation between any form of illness and any malformation of the jaws. It has been shown elsewhere that no connection could be found between the type of birth presentation and malocclusion. It has been suggested that the first child would show

more effects in jaw malformation than subsequent children. No evidence to support this theory was found. Thirty-eight of the children were first pregnancies and eighteen of these had normal occlusion. Twenty-three were second or third pregnancies and nine of these had normal occlusion.

SUMMARY

1. Sixty-one children were examined over a period of five years from the completion of the deciduous dentition to the eruption of the first permanent molars and incisors.

2. Impressions were taken at approximately yearly intervals. Six measurements were taken of each upper and lower model, and six measurements were taken of the relative positions of the upper to the lower teeth. A statistical examination of these measurements was made to show the changes taking place over the period of the investigation.

3. It was shown that there was a significant increase in the upper external arch length as compared with the internal.

4. The main increase in arch breadth took place during the eruption of the permanent incisors and not gradually over the period of the investigation, though slight increases before the eruption of the permanent incisors were shown.

5. The forward movement of the lower arch in relation to the upper during the development of normal occlusion was described. It could not be explained only through closure of space between the teeth.

6. The incidence of malocclusion during the period was noted.

7. The effects of habits and premature loss of deciduous teeth were shown.

8. No correlation between ante-natal or postnatal health and malocclusion could be demonstrated.

I would like to thank Professor Friel for much help and advice during the investigation and in the preparation of this paper. I am particularly indebted to Dr. E. R. Bransby for his statistical analysis of the measurements.

I wish to thank also the Medical and Dental Officers of Health in Ealing Borough for permission to carry out the work in their district.

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APPENDIX OF MEASUREMENTS

Description of Characters

Upper Arch

No. 1. External length (Fig. 1. A)
No. 2. Internal length (Fig. 1. B)
No. 3. Distance between the medial surface of the deciduous canine and the distal surface of the second deciduous molar—right side
No. 4. Same as 3—left side. (Fig. 1. C.)
No. 5. Intercanine breadth (Fig. 1. D)
No. 6. Extracanine breadth (Fig. 1. E)

Lower Arch

No. 7. External length (Fig. 1. A)
No. 8. Internal length (Fig. 1. B)
No. 9. Distance between the medial surface of the deciduous canine and the distal surface of the second deciduous molar—right side
No. 10. Same as 9—left side. (Fig. 1. C)
No. 11. Intercanine breadth (Fig. 1. D)
No. 12. Extracanine breadth (Fig. 1. E)

Arch relationship

No. 13. Horizontal anteroposterior distance between the distal surface of the upper canine and the medial surface of the lower canine right side (Fig. 1. F)
No. 14. Same as 13, left side.
No. 15. Horizontal anteroposterior distance between the distal surface of the upper second deciduous molar and the medial surface of the lower canine, right side. (Fig. 1. G)
No. 16. Same as 15—left side.
No. 17. Horizontal anteroposterior distance between the distal surface of the upper and lower second deciduous molars—right side (Fig. 1. H.)
No. 18. Same as 17—left side.

(a)

(b)

Characters (in mm)

Case Sex	Age (years)	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	No. 13	No. 14	No. 15	No. 16	No. 17	No. 18
1	3.6	28·7	26·2	23·4	23·2	22·5	32·1	26·0	23·6	23·5	23·8	17·8	26·4	8·1	7·3	25·5	24·8	0·4	0·0
F	4.6	28·5	26·2	23·4	23·2	23·1	32·5	26·0	23·6	23·5	23·8	17·9	26·7	8·2	7·3	25·5	24·8	0·6	0·1
	6.4	30·1	26·2	23·2	23·0	25·0	34·2	26·1	23·7	22·9	23·0	18·9	28·3	9·4	7·2	25·1	22·4	1·7	0·5
	7.8	30·0	27·1	22·0	22·0	26·5	36·9	27·0	23·7	22·8	22·6	18·2	30·3	10·1	8·3	25·8	23·7	2·1	1·0
2	3.10	29·8	26·3	24·5	24·5	22·0	33·3	26·3	23·5	25·1	26·1	19·8	30·3	9·3	8·4	27·0	26·5	0·8	0·0
F	4.10	28·9	26·3	24·0	24·5	22·0	33·0	26·5	23·8	25·0	26·0	20·0	30·5	9·5	8·9	27·2	27·1	1·2	0·3
	6.10	30·0	27·3	23·5	23·5	22·3	34·1	27·3	23·8	23·5	23·5	22·6	31·0	8·3	8·8	24·8	26·3	1·6	1·8
	7.11	30·6	27·2	23·5	23·5	22·3	37·2	27·0	23·5	23·2	23·2	23·5	33·3	8·5	11·0	23·4	28·0	2·5	3·4
3	3.9	30·0	27·6	23·6	24·0	21·4	33·5	28·0	25·6	25·0	25·0	19·0	29·2	10·4	10·3	27·9	26·5	2·8	2·8
F	5.7	30·0	27·0	23·3	23·5	21·5	33·7	26·2	25·0	23·5	23·5	18·5	30·4	10·3	10·2	26·2	27·5	3·3	3·8
	8.0	31·1	27·7	23·5	23·5	21·2	35·0	27·2	25·0	23·0	23·0	20·1	31·9	10·7	9·8	26·5	26·3	5·0	3·3
4	4.0	28·0	26·0	20·4	21·0	23·8	34·6	25·5	23·8	23·3	23·2	18·5	26·7	9·7	8·7	23·4	23·9	0·0	0·7
F	5.1	27·8	26·0	21·0	21·0	24·0	34·6	25·5	24·0	23·5	23·2	18·8	27·2	9·3	8·8	24·7	24·4	0·5	0·6
	6.4	28·0	26·0	20·1	30·1	25·6	35·6	26·0	24·0	22·2	22·1	19·6	27·6	9·3	8·7	23·0	23·0	0·9	1·2
	7.10	28·8	26·0	19·8	19·7	25·8	35·6	24·0	22·0	21·6	21·0	20·0	28·2	9·2	8·6	23·5	22·5	1·1	1·2
5	3.11	28·5	26·0	23·4	23·3	19·7	30·2	22·4	20·5	23·1	23·5	17·6	25·0	7·1	7·8	23·5	25·3	1·6	1·3
M	4.11	29·0	26·0	22·4	22·8	20·0	31·3	23·0	20·5	22·8	23·5	17·6	25·0	7·5	7·8	28·5	24·3	−1·4	−1·4
	6	28·0	26·6	22·6	23·2	21·2	32·4	24·0	21·2	22·6	23·6	17·6	25·8	5·3	9·7	21·6	25·3	−3·2	−2·1
	7.6	31·2	28·0	22·6	22·6	21·7	33·2	23·1	21·0	22·6	22·8	19·0	26·2	7·0	10·5	22·6	25·8	−3·0	−3·7
6	4	31·0	28·1	23·8	24·0	26·8	37·4	27·0	25·0	24·4	24·4	19·8	29·8	9·0	9·0	25·8	25·7	1·5	1·3
M	5.1	30·1	28·0	23·3	23·4	26·8	37·4	27·0	24·5	24·1	24·6	19·8	29·8	9·7	9·0	26·5	25·7	1·3	0·9
	6	30·1	26·8	22·9	23·3	27·6	38·4	27·5	24·5	23·7	24·0	20·8	30·8	9·1	8·6	25·4	24·7	1·0	1·0
	7.3	31·5	30·0	22·5	23·0	28·8	40·0	26·5	23·7	23·1	23·5	21·8	31·8	8·8	9·0	25·0	25·0	1·8	1·6
7	3.9	32·6	30·2	25·6	25·0	24·4	35·5	26·3	23·8	23·8	24·0	17·2	27·7	7·4	8·5	26·8	27·3	0·8	0·9
M	5.0	31·5	29·8	25·0	24·5	24·6	35·5	26·0	23·8	23·8	24·0	17·2	27·4	8·0	9·3	25·7	27·3	0·8	0·9
	6.0	30·5	28·2	25·0	24·3	25·0	36·0	25·5	23·0	23·5	23·7	18·2	28·0	8·4	9·0	26·3	26·3	1·9	2·0
	7.3	32·0	28·2	23·8	24·0	26·3	39·0	26·6	24·0	22·0	22·0	18·2	29·0	8·4	9·0	26·3	26·4	2·5	2·2
8	4.0	30·3	28·5	23·0	22·5	22·2	35·5	26·0	24·6	24·4	24·4	17·5	26·8	7·3	8·9	24·3	25·9	−2·0	0·0
F	5.0	30·0	28·0	23·0	22·5	22·8	35·5	26·2	25·0	24·5	24·5	17·3	22·3	8·0	10·3	24·5	27·0	−2·7	1·0
	6.3	31·5	28·0	22·0	21·5	25·0	37·0	27·0	24·5	24·5	24·5	18·8	29·1	6·3	9·3	22·6	25·3	−3·4	1·0
	7.6	32·3	28·0	22·0	21·5	25·2	37·3	27·0	24·5	23·5	23·5	19·5	30·0	6·8	9·3	22·3	24·5	−3·7	1·0

(c)

Case Sex	Age (years)	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	No. 13	No. 14	No. 15	No. 16	No. 17	No. 18
10	3.1	30·8	27·8	24·7	24·4	22·0	32·3	22·5	21·5	25·0	25·0	18·2	27·0	7·0	8·0	24·3	26·8	−1·7	−0·7
M	4	30·8	28·0	24·0	24·0	22·2	33·3	23·5	21·5	24·3	25·0	17·5	27·7	7·7	8·0	26·3	26·5	0·6	0·6
	5.4	30·2	28·0	24·0	24·0	23·0	34·2	24·5	22·0	25·7	24·0	18·0	27·5	8·3	7·6	27·0	26·3	0·7	1·8
	6.3	30·8	28·0	24·7	24·4	22·7	34·2	25·5	22·2	25·0	24·4	18·2	28·0	8·3	8·3	26·5	24·2	0·7	2·7
12	4.3	31·0	27·5	24·0	23·5	20·1	31·8	23·3	21·5	23·0	23·1	17·0	26·3	7·7	8·0	26·3	24·7	0·3	0·3
M	5.0	31·5	27·5	24·0	24·0	20·5	32·2	23·3	21·5	23·0	23·0	18·0	27·0	7·7	7·3	24·5	23·0	0·8	0·6
	6.1	30·5	27·0	23·0	24·0	20·5	33·0	23·3	21·5	23·0	23·0	18·0	27·6	7·3	8·3	24·3	24·3	1·3	1·3
	7.2		26·8	23·0	24·0	23·5	35·5	23·5	21·5	23·0	23·0	19·0	28·3	8·0	8·3	23·8	24·5	1·5	1·3
13	4.0	30·0	26·0	21·9	21·5	20·0	32·0	27·3	25·0	24·2	24·2	16·5	26·3	10·3	9·8	26·0	26·2	1·9	1·7
M	5.6	29·6	25·0	21·9	21·5	19·0	31·3	26·4	25·0	23·0	24·1	16·2	26·3	10·0	9·7	25·4	26·4	2·2	2·2
	6.6	30·0	26·0	21·0	21·5	19·3	32·0	26·5	25·0	23·0	24·0	17·2	28·2	10·1	10·0	25·7	25·3	3·3	3·5
	8	30·0	28·2	21·0	21·0	20·0	32·6	26·5	24·0	22·5	23·5	18·0	29·2	11·2	9·4	25·5	24·3	3·3	3·5
14	3.6	28·2	24·3	23·2	23·3	21·4	32·6	24·4	22·0	24·8	24·8	17·0	26·1	9·2	9·4	26·1	26·5	0·0	0·0
M	5.6	28·6	24·4	23·3	23·3	21·3	33·0	24·4	22·0	24·8	24·8	17·2	27·0	9·7	9·8	26·6	26·8	1·0	1·2
	7.3	29·8	25·8	23·3	23·3	23·6	34·7	25·9	23·1	24·8	24·8	19·0	28·4	10·3	10·5	27·4	27·7	1·6	1·8
15	3.6	31·0	28·2	24·1	24·1	23·3	36·8	26·8	24·9	23·6	23·6	20·2	29·0	7·0	8·0	23·3	23·0	−2·4	−2·4
M	5.0	30·3	27·5	24·1	24·1	22·6	35·0	26·8	23·6	24·1	24·1	19·6	28·3	7·3	6·0	23·8	23·1	−2·4	−2·7
	6.6	30·5	26·8	24·1	24·1	23·3	35·2	26·2	23·0	24·1	24·1	19·3	28·0	7·4	7·3	23·3	23·6	−2·4	−2·4
	7.6	31·0	27·2	24·0	24·0	23·6	36·4	27·2	23·2	24·1	24·1	20·0	30·7	7·6	7·7	22·5	21·8	−4·4	−2·4
16	2.10	30·8	28·1	24·2	24·2	21·0	32·6	25·5	23·0	24·0	24·0	15·2	25·8	9·4	8·6	26·5	26·1	0·5	0·7
M	4.0	30·8	27·3	24·2	24·2	20·3	31·4					16·3	25·6	9·3	8·0	26·5	25·9		
	5.2			24·1	24·2	20·5	31·5					16·4	26·8	9·3	8·0		25·7		
	7.0			24·2	24·2	22·7	33·7					18·6	28·3	9·3	8·0		25·7		
17	3.6	27·1	23·6	22·0	23·1	21·0	32·4	24·3	22·8	23·0	23·0	16·5	26·3	8·5	6·1	24·5	22·3	−1·9	−2·8
M	4.10	26·0	23·6	22·0	22·5	21·0	32·3	24·3	22·8	22·2	22·5	16·5	27·2	9·3	6·1	24·8	22·0	0·0	−2·6
	6.0	26·8	23·6	21·8	21·8	21·0	32·3	25·3	24·2	22·0	22·0	16·8	27·2	9·3	7·0	24·3	22·2	0·0	−2·4
	7.6	29·1	26·1	21·8	21·8	22·5	33·9	27·0	23·2	22·0	22·0	18·2	29·2	8·5	8·3	21·6	20·8	0·0	−3·4
18	4.0	25·1	24·5	21·5	21·5	22·6	31·5	22·3	21·0	21·2	21·2	17·2	27·0	7·0	6·3	21·8	23·4	0·0	0·0
M	5.6	26·2	24·8	22·2	21·7	21·0	28·0	22·3	20·8	20·0	20·0	17·2	26·0	7·1	6·8	22·5	23·0	2·3	2·4
	7.6	27·0	25·0	20·6	20·6	22·3	33·0	21·9	20·0	18·5	18·5	19·0	30·2	6·5	7·3	20·8	21·0	2·2	2·5
19	3.3	30·6	28·0	24·1	23·9	20·8	33·3	26·5	24·0	24·5	24·7	17·0	26·4	8·8	9·1	26·0	26·6	0·0	0·0
M	4.6	30·0	27·8	23·2	23·7	20·8	33·5	26·5	24·0	24·4	24·3	17·0	26·5	9·3	9·2	26·0	26·1	1·1	1·2
	6.0	30·0	27·8	23·1	23·6	21·2	33·8	26·5	24·1	24·4	24·3	17·2	26·7	9·4	9·3	25·9	26·1	1·7	1·5
	7.3	31·9	28·5	23·1	23·6	21·5	34·1	27·1	24·6	24·3	24·3	17·4	27·0	9·4	9·3	25·5	25·8	2·6	2·5

(d)

Case Sex	Age (years)	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No.'12	No. 13	No. 14	No. 15	No. 16	No. 17	No. 18
20	3.4	29·5	27·0	23·0	23·7	21·5	33·2	26·5	2·38	24·2	24·6	17·3	27·2	9·4	8·2	26·8	26·3	0·2	0·3
F	4.6	29·5	27·0	23·6	23·4	22·5	33·2	26·5	23·8	24·4	24·4	17·0	27·0	10·3	8·3	26·6	26·0	1·0	0·8
	5.6	29·5	27·0	24·0	23·5	22·0	34·1	24·7	22·5	22·8	22·8	17·7	27·0	9·3	8·0	24·8	25·0	2·5	2·5
	6.11			23·2	23·2	23·4	36	24·7	22·5	22·0	22·0	18·0	29·3	8·3	8·0	25·0	24·5	2·8	2·8
21	3.11	28·1	25·1	22·8	22·8	17·2	29·5	26·0	23·5	24·1	24·1	14·8	23·8	9·6	8·2	26·3	25·3	0·3	0·0
F	5.2	28·0	25·0		22·8	17·2	29·5	26·0	23·5	24·1	24·1	15·5	24·0	10·0	9·2		24·8		1·3
	7.2	29·8	26·3		22·0	20·3	32·3	26·2	24·3	23·7	23·7	17·1	27·0	11·6	7·5		25·6		1·6
23	3.1	28·8	25·2	23·2	22·9	20·2	31·6	25·3	24·0	23·4	23·2	16·9	25·7	7·5	8·1	25·1	25·3	0·5	1·4
M	4.2	29·0	27·1	23·7	23·7	22·1	32·2	25·5	23·0	23·4	23·0	16·8	25·7	9·4	8·6	26·1	25·5	1·3	2·2
	6.2	30·0	27·2	22·8	22·8	21·3	33·2	24·3	23·0	22·2	22·5	16·3	27·0	9·3	10·8	26·1	27·0	2·3	2·8
	7.6	30·0	27·5	22·0	22·0	20·2	32·2	24·6	23·0	21·2	21·2	16·8	27·5		7·9		24·4	1·8	2·3
24	3.1	29·8	25·5	22·4	22·4	20·5	31·8	25·8	23·3	23·2	23·2	16·6	25·3	8·2	8·3	24·3	24·5	0·6	1·0
M	4.2	29·8	26·3	22·5	22·5	21·0	33·9	25·6	23·0	23·5	23·5	17·0	26·3	9·7	8·9	25·3	26·3	1·0	1·5
	6	31·3	27·0	22·5	22·5	21·2	34·0	25·0	22·3	23·5	23·3	15·0	26·7	9·6	11·5	25·7	26·3	3·3	4·4
	7.6	31·3	27·0	22·5	22·5	20·0	34·0	24·6	23·0	19·2				9·2		24·7		3·8	3·0
25	3.4	28·5	25·6	24·2	24·2	24·3	34·0	25·6	22·0	23·4	23·2	19·8	28·0	8·6	8·3	24·9	24·9	0·0	0·0
M	4.6	29·0	25·6	24·2	24·2	23·3	34·5	25·7	22·2	23·4	23·2	19·0	28·2	8·7	8·3	25·4	25·3	0·0	0·0
	5.6	29·8	26·0	24·2	24·2	24·4	35·2	26·0	23·1	23·5	23·3	19·0	29·0	9·1	8·7	26·0	26·3	1·1	0·8
	6.7	29·8	26·1	24·2	24·2	25·0	36·2	26·0	23·0	23·5	23·3	20·2	30·1	9·8	8·9	24·9	24·3	1·3	0·8
26	4.1	29·1	26·2	21·2	21·2	17·1	27·5	23·0	20·8	21·8	21·8	15·5	23·4	7·0	8·2	22·5	23·3	—2·7	1·3
F	5.6	28·4	26·0	21·0	20·9	18·7	28·4	23·0	20·8	21·8	21·7	15·7	24·6	8·8	9·0	24·3	23·0	2·3	2·7
	6.6	29·5	26·4	21·0	21·0	18·8	28·5	23·4	20·9	21·5	21·4	16·0	24·6	8·3	8·7	23·1	22·8	2·3	2·7
	8.0	30·2	26·7	21·0	21·0	18·8	28·5	23·4	21·0	21·4	20·6	16·3	25·0	8·6	8·3	24·0	24·0	2·3	3·2
28	4.0	28·2	25·4	23·1	23·3	25·0	36·1	27·5	25·0	24·6	24·7	20·1	30·0	10·5	10·0	26·3	25·9	1·6	1·0
M	5.6	28·2	25·5	23·2	23·3	25·0	36·5	28·1	25·2	24·4	24·5	20·1	30·0	10·2	10·3	26·0	25·4	2·0	1·6
	6.9	32·0	28·0	22·2	22·4	26·2	37·7	28·1	25·3	23·6	23·7	22·0	31·7	10·3	10·3	25·4	25·3	2·4	1·6
	8.0	33·9	29·0	23·5	24·2	26·3	37·7	28·5	25·3	24·6	24·7			11·5	11·0	25·4	25·7	2·6	2·3
30	3.6	28·8	27·0	22·9	22·9	23·0	34·8	26·4	22·8	24·6	24·6	18·0	27·2	9·3	8·6	26·3	25·7	0·0	0·0
M	4.9	28·5	26·2	22·9	22·9	23·2	35·0	26·4	22·8	24·6	24·6	17·8	27·2	9·4	8·7	26·1	25·7	0·4	1·3
	5.10	27·2	25·2	21·0	20·6	23·2	35·0			24·6		18·0	27·2	9·6	9·3	26·2	25·8	0·6	
	7.4	29·0	35·0	20·0	19·8	25·8	37·4			23·9		18·2	28·8	10·5	8·1	22·8	21·5	0·0	
31	3.8	29·4	25·4	23·7	23·2	24·0	35·1	27·0	24·2	26·0	26·0	20·2	29·8	12·6	11·5	29·1	29·3	2·0	2·2
M	5.0	29·0	25·0	23·7	23·2	25·0	36·2	27·0	23·2	25·2	25·2	19·4	29·2	12·8	11·3	29·5	29·3	3·8	4·3
	6.2					25·0	36·2	28·0	26·0	25·2	25·2	20·0	29·6	11·6	12·8				
	7.11					26·4	38·0	29·0	25·0	25·2	25·2	21·5	32·0	12·6	13·0				

(e)

Case Sex	Age (years)	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	No. 13	No. 14	No. 15	No. 16	No. 17	No. 18
32	3.6	28·0	26·0	20·4	21·0	23·7	34·6	25·5	23·8	23·3	23·3	18·7	26·7	9·7	8·7	23·4	23·9	0·0	0·7
F	4.6	28·0	26·0	21·6	21·0	24·0	34·6	25·5	24·0	23·5	23·3	18·8	27·2	9·3	8·8	24·7	24·5	0·4	0·6
	5.6	28·0	26·0	20·5	21·0	25·6	35·6	26·0	24·1	20·1	22·1	19·6	27·2	9·3	8·8	23·0	23·1	0·8	1·1
	6.7	28·8	26·0	19·9	20·0	25·8	35·6	24·0	22·5	21·5	21·5	20·1	28·2	9·2	8·6	23·8	22·6	1·1	1·3
33	4.0	31·2	28·8	24·6	24·7	24·5	35·5	28·0	25·8	25·2	25·3	21·8	32·0	11·0	10·0	27·6	27·7	1·5	1·8
M	5.3	30·5	28·0	24·2	24·2	24·5	35·4	26·7	24·9	25·2	25·2	21·9	32·0	11·2	10·2	27·6	27·6	2·2	2·5
	6.6	31·8	29·0	23·0	23·0	26·4	39·8	27·6	25·2	25·3	25·1	24·4	37·0	11·5	10·6	28·4	26·3	3·1	3·0
34	4.0	31·3	29·0	23·6	23·5	26·1	36·4	29·1	2·63	25·2	25·4	21·7	29·7	10·3	9·8	26·6	26·8	1·6	1·5
M	5.0	31·6	29·0	23·0	23·4	26·6	36·9	28·0	26·0	25·0	25·0	21·7	30·7	10·2	9·8	27·5	26·8	2·0	1·2
	6.6	33·0	29·6	22·7	22·8	28·2	38·9	29·0	26·0	24·5	24·0	22·7	32·3	9·9	8·8	26·3	26·3	2·1	1·3
	7.6	33·0	29·6	22·5	20·7	29·0	39·7	29·6	26·4	24·2	23·8	22·7	32·3	10·7	10·6	26·3	23·9	2·5	0·5
36	3.6	28·3	26·0	22·4	22·3	21·7	33·0	26·2	23·1	24·0	25·0	16·0	26·5	10·1	9·9	25·8	25·5	1·7	0·8
M	4.6	28·3	26·0	22·4	22·3	21·8	33·0	26·6	23·1	23·5	24·7	16·0	26·5	11·1	10·8	24·1	25·3	1·7	0·8
	5.6	29·0	26·0	22·0	22·0	22·5	34·2	26·5	23·1	23·5	24·0	16·5	27·5	10·5	10·3	24·3	25·7	2·0	1·3
	7.2	30·3	26·0	22·0	21·0	24·4	35·8	26·5	23·1	23·3	24·0	18·2	27·5	11·2	10·8	24·6	25·7	2·3	1·8
37	3.6	28·5	25·4	24·0	23·5	20·6	33·0	26·8	23·4	26·5	26·6	19·3	29·3	9·5	9·3	28·3	28·0	0·6	0·7
M	4.6	28·5	26·0	24·2	23·0	20·6	33·5	26·7	23·3	25·6	25·1	20·0	29·5	9·7	9·3	27·0	27·3	1·2	0·9
	5.6	28·5	25·7	23·5	23·7	21·0	33·5	26·5	23·0	24·7	24·7	20·0	31·0	8·8	8·3	25·8	25·8	1·3	1·5
	6.6	28·0	25·0	24·0	25·0	22·5	36·0	26·1	22·7	25·0	24·5	20·0	31·5	8·3	9·4	26·4	25·6	1·8	1·5
38	3.6	28·0	25·2	21·7	21·5	21·3	31·7	24·0	21·5	22·3	22·2	16·3	24·5	8·7	8·2	24·3	23·8	1·0	0·2
F	4.6	28·0	25·3	21·4	21·4	21·3	31·5	24·1	21·5	22·3	22·2	16·4	24·5	8·8	8·3	24·4	23·7	1·3	0·6
	5.6	27·5	24·0	21·2	21·2	21·3	31·5	23·2	21·1	21·7	22·0	16·3	24·7	9·3	8·6	25·6	24·4	3·0	1·7
	6.6	26·6	23·0	21·7	21·5	23·0	33·7	22·7	20·0	21·7	22·0	18·0	26·0	9·3	8·1	23·5	23·3	3·0	2·0
40	4.1	31·5	29·0	24·0	24·2	22·4	34·4	26·4	24·6	25·5	25·4	18·1	27·4	9·0	9·3	26·7	26·3	0·2	1·0
F	5.1	31·5	29·1	24·4	24·0	22·5	34·5	27·0	24·5	25·0	24·7	18·1	28·4	8·5	9·5	26·6	26·5	0·8	1·3
	6.0	31·5	29·0	24·5	24·0	22·5	35·0	27·0	24·5	25·0	25·1	18·1	29·0	9·8	9·3	26·4	26·3	0·8	1·2
	7.1	31·6	29·0	24·0	23·2	23·5	26·5	26·0	23·5	24·1	24·2	19·1	30·0	9·3	10·5	26·4	26·4	2·3	3·0
41	3.2	28·2	25·8		24·7	23·8	34·7	26·0	23·0		26·1	18·7	27·7	10·3	8·8		26·3		0·6
M	4.2	28·6	25·8	25·0	24·5	24·3	35·0	26·0	23·0	25·4	26·4	18·7	28·0	10·0	9·6	27·3	27·5	0·0	0·6
	5.6	28·6	25·8	25·0	24·6	24·8	36·0	25·6	23·0	25·5	26·4	18·7	29·0	9·6	10·1	26·5	28·1	0·0	0·7
	6.8	29·2	26·0	24·7	24·7	25·3	36·4	25·6	23·0	25·5	26·4	19·4	29·0	10·7	10·4	27·8	27·0	0·8	0·8
42	3.3	28·5	25·3	21·1	23·0	22·0	32·6	25·0	23·0	23·5	23·5	16·4	24·5	10·3	9·3	25·5	25·4	0·0	0·2
M	4.3	28·5	28·5	23·0	23·5	22·0	33·6	25·0	23·0	24·0	23·8	16·4	25·5	10·3	9·3	25·6	25·4	1·3	1·3
	5.8			22·2		22·0	33·6	24·5	22·5	23·8	23·8	17·0	26·5	10·3	11·3	25·3		0·8	
	6.7			22·2		23·0	35·0	26·1	22·0	23·2	23·1	17·0	28·1	10·3	10·8	25·3		2·8	

(f)

Case Sex	Age (years)	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	No. 13	No. 14	No. 15	No. 16	No. 17	No. 18
43	4.0	26·8	25·4	22·0	22·5	24·9	36·6	24·5	23·0	24·0	25·0	19·0	28·5	9·3	0·3	24·3	23·8	0·3	0·0
M	5.1	27·7	25·5	22·0	22·5	25·4	37·2	25·0	23·5	24·0	25·0	19·0	29·0	10·3	9·3	24·3	24·5	0·3	0·6
	6.0	27·7	25·0	22·1	23·0	26·0	37·3	25·0	23·5	23·5	24·6	19·0	29·0	10·3	9·3	24·5	24·6	0·6	1·3
	7.8	27·7	25·0	22·7	22·0	27·4	38·7	25·0	24·2	23·5	24·0	19·0	30·0	10·3	9·3	24·7	24·8	1·3	1·4
44	4.1	27·5	24·0	22·6	21·3	19·2	29·9	23·9	21·0	22·0	22·0	15·6	24·7	6·4	7·5	22·1	24·4	−2·4	2·0
M	5.2	28·7	24·9	22·1	21·7	19·2	29·9	24·9	22·7	22·1	22·1	15·6	26·3	6·4	8·1	22·1	23·7	−2·6	2·0
	6.6	28·9	26·4	22·0	22·0	20·9	32·5	24·9	23·1	22·1	22·1	17·1	26·9	6·3	9·4	23·0	23·6	−3·1	2·5
	7.6	29·2	26·9	22·0	22·0	20·9	32·5	25·5	23·1	22·1	22·1	17·1	27·2	8·9	9·4	23·0	23·6	−3·1	2·6
46	3.9	29·8	26·2	23·2	23·2	19·9	31·5	26·1	23·4	23·0	23·0	15·8	24·6	8·4	6·8	25·3	23·5	−2·0	0·0
F	4.11	29·8	26·2	23·1	23·1	20·3	32·0	26·1	23·3	23·0	23·0	15·6	26·0	8·5	9·4	25·1	25·6	−0·0	2·0
	6.2	30·0	25·3	23·1	23·1	21·5	32·3	26·1	23·5	23·0	23·0	15·6	26·3	8·5	8·2	24·3	25·5	1·0	2·3
	7.4	30·0	26·4	23·1	23·1	21·5	33·4	26·3	25·0	23·0	23·0	16·0	26·3	10·4	8·4	26·6	24·3	3·0	2·8
47	3.4	28·8	25·2	23·2	22·8	20·2	31·6	25·3	24·0	23·4	23·2	18·9	25·7	7·6	8·0	25·1	26·0	0·6	0·4
F	4.5	29·0	27·1	23·7	23·7	22·1	32·6	25·4	23·0	23·4	23·0	16·9	25·9	9·4	8·4	26·1	26·2	1·3	2·2
	5.5	30·0	27·2	22·8	22·8	21·3	33·2	24·3	24·1	22·2	22·5	16·4	26·0	9·4	10·8	26·1	27·0	2·3	2·4
	6.6	30·6	27·5	22·0	22·0	20·2	32·6	24·6	24·0	21·2	21·2	16·8	27·5		8·0		24·7	2·2	2·5
48	3.9	27·6	24·1	23·0	21·9	20·3	31·4	24·0	21·5	21·5	21·8	15·2	26·7	6·2	6·3	23·3	22·3	−1·9	−2·8
F	5.2	27·5	24·3	22·8	22·3	19·9	32·5	24·2	22·0	22·5	22·3	16·0	26·5	6·1	6·5	23·3	23·3	−1·7	0·0
	6.4	27·2	25·0	22·5	22·5	21·0	32·6	24·9	22·0	22·2	22·2	16·5	27·0	6·0	6·8	21·3	23·4	−2·4	1·6
	7.6	30·1	27·0	22·5	22·5	22·9	34·0	25·8	22·2	22·2	22·2	16·8	28·6	6·7	7·8	21·3	23·3	−2·4	1·6
49	4.2	27·6	24·0	22·6	21·3	19·3	30·0	24·0	21·1	22·0	22·0	15·7	24·6	6·3	7·5	22·1	24·5	−2·4	2·0
F	5.4	28·7	25·0	22·0	21·9	19·3	30·0	25·0	22·8	22·1	22·1	15·8	26·4	6·3	8·6	22·1	23·8	−2·6	2·0
	6.8	29·0	26·5	22·0	22·0	21·0	32·5	25·0	23·2	22·0	22·1	17·2	27·0	6·3	9·3	23·0	23·6	−4·1	2·5
	8.6	29·3	27·0		22·0	23·0	34·2	25·6	23·2		22·1	17·2	28·3	8·8	7·7		21·6		2·5
50	3.0	28·9	26·3	22·2	22·2	23·2	31·3	26·7	24·0	23·2	23·2	18·2	25·3	6·3	7·5	24·2	22·3	0·0	0·0
F	4.0	30·5	28·6	23·0	22·6	23·2	34·0	28·0	24·7	23·5	23·5	18·2	26·6	8·9	9·3	26·8	26·5	1·1	1·3
	5.2	30·8	28·0	23·0	23·0	21·9	32·3	27·0	24·2	23·5	23·5	16·5	27·0	9·1	8·5	25·8	25·6	2·3	2·4
	6.8	31·1	28·2	23·0	23·0	24·3	35·2	27·0	24·0	23·2	23·2	18·2	28·3	8·5	8·8	24·3	24·6	2·6	2·8
51	3.7	27·8	25·0	22·3	22·0	21·3	33·0	2·45	22·0	22·0	22·3	16·3	26·0	9·1	7·9	24·4	24·4	1·0	0·3
M	5.10	27·8	25·0	22·4	22·0	21·4	33·9	25·0	23·1	22·4	22·3	16·5	26·0	9·1	7·5	24·4	24·4	1·0	0·3
	7.6	29·5	23·0	22·3	22·0	23·5	36·6	25·4	22·3	22·2	22·3	19·4	30·2	10·0	7·5	23·9	23·9	2·5	1·0
52	3.11	31·1	28·3	24·0	25·0	23·6	35·5	27·3	25·3	25·2	25·2	20·8	30·6	8·7	8·1	25·7	25·7	−2·6	0·0
M	5.0	31·1	28·3	24·3	25·0	24·2	36·3	27·3	25·4	25·0	24·5	20·7	31·2	7·7	7·7	25·2	25·8	−2·6	0·4
	6.2	31·3	27·3	23·2	23·7	26·5	38·8	27·6	25·6	23·6	23·7	23·3	34·0	7·7	7·3	23·8	24·5	−2·8	0·4
	7.6	31·0	26·7	22·6	22·9	26·5	39·2	27·5	24·3	23·5	22·2	23·3	34·2	9·3	7·5	23·5	22·9	−2·8	1·5

(g)

Case Sex	Age (years)	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	No. 13	No. 14	No. 15	No. 16	No. 17	No. 18
53	2.0					24·1	34·2					19·2	28·0	8·2	8·3				
F	3.2	32·1	29·3	25·4	25·4	22·2	35·0	27·3	24·0	25·0	25·0	17·8	28·0	7·8	7·5	26·0	26·0	0·0	0·0
	6.2	32·0	29·0	25·5	25·4	22·4	35·6	27·5	25·0	25·0	25·0	18·8	29·0	7·6	7·5	26·3	26·7	—1·9	—1·9
54	3.3	33·2	30·0	24·0	24·0	23·2	34·0	24·4	22·5	23·8	23·7	18·8	27·4	7·5	7·3	24·0	24·1	—1·9	—1·7
F	4.4	34·1	31·0	25·0	24·4	22·0	33·4	24·0	21·0	24·0	23·7	18·0	27·3	7·3	8·3	25·3	25·3	0·8	0·6
	6.0	32·2	30·0	24·0	23·7	22·0	33·6	24·0	21·0	24·0	23·7	18·6	27·4	7·0	8·3	23·5	24·3	0·8	1·3
	7.1	33·0	30·0	23·0	23·0	23·2	35·0	24·0	21·1	24·0	23·7	19·0	28·0	9·3	9·3	25·3	24·3	1·3	1·8
55	3.6	30·7	27·4	23·6	23·6	23·7	35·2	27·2	23·5	25·0	25·0	19·0	28·0	10·2	8·6	28·5	26·3	0·0	0·0
M	4.3	29·7	26·5	23·8	23·8	23·8	35·3	27·0	24·0	25·0	25·0	17·2	28·3	10·3	8·3	26·3	25·3	0·5	0·0
	5.6	30·7	27·5	23·2	23·6	24·2	36·2	27·3	24·0	24·8	24·8	19·0	29·0	9·3	8·3	26·3	25·5	0·6	0·3
	6.6	31·5	27·8	23·2	23·5	24·5	36·5	27·9	24·2	24·8	24·8	19·2	29·3	9·3	8·4	27·3	25·6	0·8	0·3
57	3.8	28·5	26·0	23·8	23·8	21·6	32·0	24·3	22·0	24·0	24·0	18·3	26·5	8·3	8·3	24·6	25·3	0·3	0·3
F	5.0	28·5	26·0	22·5	22·5	22·0	33·0	24·3	22·0	22·3	22·5	19·0	27·2	7·9	8·2	25·3	25·3	0·8	0·8
	6.0	28·5	26·0	24·0	23·0	22·5	34·0	25·0	22·8	23·0	23·0	19·0	27·5	7·3	8·3	23·1	24·3	0·8	1·3
	7.1			23·6	23·6	26·0	36·2	25·0	22·8	23·0	23·0	22·0	29·0	10·3	10·6	26·3	25·9	1·5	2·5
58	3.11	26·7	22·0	21·8	21·8	19·8	30·0	23·0	20·1	21·8	21·8	15·9	24·6	7·5	8·3	21·8	21·2	—1·6	—3·9
F	5.0	27·2	22·3	22·0	22·0	20·0	31·2	23·0	20·0	21·8	21·8	16·0	25·0	6·6	6·3	21·8	22·3	—3·3	—3·7
	6.2	27·5	21·8	22·0	22·0	20·0	31·0	22·8	21·6	21·8	21·8	16·0	25·6	6·8	6·3	21·3	22·3	—3·3	—4·0
	7.8	29·3	23·4	22·0	22·0	22·2	33·5	24·5	22·8	21·8	21·8	18·7	27·5	6·9	6·4	21·3	22·4	—3·3	—4·0
60	3.3	30·2	29·5	23·0	23·2	24·0	35·6	26·7	25·0	24·5	24·5	17·2	27·4	10·8	9·7	26·5	27·3	0·0	0·7
M	4.6	30·5	29·5	23·0	23·0	24·0	35·5	26·7	24·5	24·0	24·2	17·3	27·0	10·3	9·7	26·3	26·5	0·5	0·7
	5.6	30·5	28·5	22·8	23·0	24·0	35·5	27·5	25·0	24·0	24·0	17·5	27·2	9·3	9·1	26·3	25·3	0·8	0·8
	6.6	30·5	29·0	22·8	23·0	24·0	26·7	27·5	25·0	24·0	24·0	17·6	28·2	9·3	9·3	25·9	26·5	1·2	1·2
61	3.11	29·8	27·2	23·7	23·0	21·4	34·0	27·0	23·6	24·5	24·5	16·4	27·4	9·3	9·3	26·3	26·6	1·0	1·1
M	5.2	30·3	27·1	23·7	23·2	21·8	34·0	27·0	23·9	24·0	25·2	17·0	27·6	9·3	9·2	27·5	26·9	2·0	1·8
	6.3	30·8	27·5	23·5	23·5	21·8	34·8	26·5	23·0	23·8	24·0	17·9	28·0	9·8	10·1	26·8	27·3	2·1	2·8
	7.3	29·4	27·2	22·5	22·5	22·8	35·4	26·0	22·0	22·4	22·6	18·6	28·8	8·5	9·5	24·3	25·3	2·9	2·9
62	3.6	29·5	27·7	22·0	22·0	21·5	32·2	26·8	25·5	23·0	24·2	17·8	27·1	7·5	7·8	23·9	24·3	0·0	0·0
M	5.6	30·3	27·0	22·5	22·5	23·0	33·7	26·8	25·0	22·8	23·8	19·0	29·0	7·3	7·8	23·9	24·3	0·6	1·1
	6.6	28·3	25·0	22·0	22·0	23·0	34·0	28·0	25·0	22·0	23·0	20·0	30·8	7·8	9·3	24·3	24·3	0·6	2·3
	7.6	30·8	26·7	22·0	22·1	24·5	34·2	28·1	25·1	22·0	23·0	21·2	31·1	7·8	9·4	24·3	24·3	1·8	4·3
63	3.11	28·8	26·2	23·7	23·7	21·6	33·4	26·9	24·1	23·9	24·7	17·2	26·8	9·3	9·3	25·4	25·4	0·0	0·0
M	5.1	28·8	26·1	23·5	23·6	21·6	33·4	26·7	24·1	24·0	24·7	17·2	27·2	9·0	8·3	25·3	25·3	0·0	0·0
	6.2	29·5	26·7	22·7	23·0	22·9	35·0	26·9	24·2	23·2	23·2	19·0	28·0	7·8	7·9	23·3	24·1	—2·1	—2·2
	7.6	30·2	27·4	22·5	22·8	24·2	35·8	27·5	25·1	23·1	23·1	19·6	28·9	7·8	7·9	23·3	23·9	—2·2	—2·2

(h)

Case Sex	Age (years)	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	No. 13	No. 14	No. 15	No. 16	No. 17	No. 18
64	4.0	29·0	26·5	23·6	23·6	22·3	34·0	24·8	22·0	23·5	23·4	16·9	25·7	8·5	9·4	25·3	26·7	0·0	2·0
M	5.1	29·0	26·4	23·6	23·6	22·3	34·6	25·0	22·2	24·0	23·5	16·9	26·6	10·1	10·5	26·8	27·3	1·8	2·7
	6.1	29·5	26·4	23·5	23·6	22·5	34·6	25·4	23·0	23·5	23·4	17·2	27·0	10·2	10·4	27·1	27·5	2·3	2·8
	7.3	31·3	27·4	23·6	23·6	23·1	35·4	25·5	23·0	23·6	23·4	17·5	27·8	10·2	10·3	26·8	27·3	3·2	3·2
65	3.4	27·0	22·9	21·8	21·8	20·3	31·4	23·2	20·8	21·8	21·8	16·9	26·2	7·5	7·1	23·4	22·9	0·0	0·0
F	4.6	26·9	22·9	21·8	21·8	20·5	31·8	23·1	20·3	21·9	21·9	16·3	25·8	7·5	7·0	23·5	22·5	−2·0	−1·7
	6	27·1	22·3	21·8	21·8	20·9	32·2	24·4	22·2	21·9	21·9	16·5	26·4	7·6	7·2	23·4	22·1	−2·0	−1·7
	7.6	29·8	24·4	21·8	21·8	22·8	33·9	26·2	23·7	21·9	21·9	18·6	28·6	7·6	7·1	23·4	23·1	−2·6	−2·5
66	3.11	31·0	28·0	23·8	23·7	21·4	33·5	28·1	25·5	25·0	25·0	18·5	28·8	10·1	7·5	26·3	24·0	0·0	−2·4
M	5.0	30·5	26·5	24·0	23·7	21·3	33·5	28·0	25·3	25·0	25·0	19·4	30·0	10·6	7·8	26·7	26·1	1·5	0·0
	6.1	31·5	28·0	24·0	24·0	21·5	33·6	28·0	26·0	23·8	23·5	20·0	30·5	9·3	7·3	26·3	24·5	1·8	1·0
	7.3	31·5	28·0	23·3	23·2	24·0	36·0	27·0	24·0	22·5	22·0	22·0	33·0	9·8	8·7	25·2	26·5	3·3	1·0
67	3.8	30·1	27·2	23·0	23·0	21·5	32·0	27·3	24·8	23·2	23·8	14·9	25·0	8·4	9·3	25·3	26·2	0·3	0·6
F	4.9	30·0	27·0	23·2	23·2	21·9	32·4	27·2	23·3	23·2	24·0	15·0	26·0	9·3	9·3	26·1	26·8	2·2	1·8
	6.6	29·3	26·4	23·2	23·2	21·0	32·9	27·2	24·1	23·2	23·2	15·5	26·3	10·0	9·9	26·3	26·4	3·1	2·6
	7.6	29·8	27·0	23·0	23·0	22·0	34·0	27·1	24·0	23·0	23·2	16·4	27·4	9·5	10·4	26·1	25·3	3·1	2·7
70	3.6	28·3	26·7	23·0	22·8	22·0	33·5	24·0	22·5	22·4	23·0	16·2	27·0	10·4	9·5	25·5	25·3	0·3	0·3
M	5.0	28·3	26·7	22·5	22·5	22·0	33·5	24·0	22·0	22·2	23·0	16·2	27·0	9·3	8·3	25·6	23·7	1·2	1·3
	6.0	32·0	27·5	21·2	22·5	24·2	36·0	25·5	22·0	21·2	21·8	18·8	29·0	8·6	8·3	23·6	24·3	1·8	2·0
	7.3	32·0	27·5	21·2	21·5	24·5	36·8	25·5	22·0	21·2	21·8	18·8	30·0	8·6	9·5	23·1	23·8	2·3	2·8
71	3.11	29·9	27·3	23·7	23·1	21·5	33·5	27·1	23·7	24·5	24·5	16·5	27·5	9·4	9·4	26·4	26·7	1·0	1·1
F	5.2	30·4	27·2	23·7	23·2	21·9	33·5	27·1	24·0	25·0	25·0	17·1	27·7	9·4	9·3	27·5	27·0	1·9	1·8
	6.3	30·9	27·6	23·5	23·5	21·9	36·0	26·6	23·1	24·0	24·0	18·0	28·1	9·8	9·8	26·9	27·4	2·1	2·7
	7·5	29·5	26·3	23·0	23·0	23·0	36·8	26·1	22·1	23·8	23·8	18·6	28·9	8·5	9·1	24·4	25·4	2·3	2·9
72	3·6	31·0	28·0	23·8	24·0	26·8	34·1	27·0	25·2	24·4	24·2	19·7	29·7	9·0	9·0	25·8	25·7	1·5	1·3
M	5·1	30·3	28·0	23·3	23·4	26·9	34·1	27·0	25·2	24·2	24·4	19·8	29·8	9·6	9·0	26·0	25·7	1·5	1·6
	6	30·1	27·5	22·9	23·3	27·6	34·9	27·5	25·2	23·7	24·0	20·8	30·9	9·1	8·0	25·4	25·7	1·5	1·6
	7.1	31·5	28·0	22·5	23·0	28·8	35·5	27·5	24·8	23·5	23·5	21·8	31·9	8·8	8·0	25·0	25·0	1·7	1·8
73	2.10	31·2	28·7	23·2	23·2	22·2	37·4	27·3	24·0	23·3	23·3	18·6	27·0	6·5	8·8	23·0	24·3	−2·4	0·0
M	3.10	30·5	27·2	23·2	23·2	22·5	37·4	27·0	23·8	23·3	23·3	18·5	27·2	6·8	8·3	24·3	25·4	−2·4	−2·1
	4.10	28·5	26·5	23·2	23·2	22·0	38·4	27·0	23·8	23·3	23·3	18·5	27·5	6·0	8·3	24·3	24·3	−2·7	−2·4
	6.2	30·5	26·0	23·2	23·2	22·0	40·1	26·5	25·0	23·2	23·2	18·0	28·4	6·5	7·5	22·0	22·8	−2·7	−2·6

Occlusal Effects of Tuberculated Lateral Incisors

J. S. Beresford, B.D.S. (N.Z.), H.D.D. (Ed.)

Lateral incisors in the upper jaw are known to be subject to a great deal of variation. The type of anomalous upper lateral incisor which has a cusp rising from the posterior cervico-marginal ridge is not uncommon. According to Bolk it is an over development of the deuteromere. It may be as high as the rest of the crown and there is generally a marked central median ridge extending from the tuber to the incisal edge (figure 1). An X-ray plate which has been exposed to

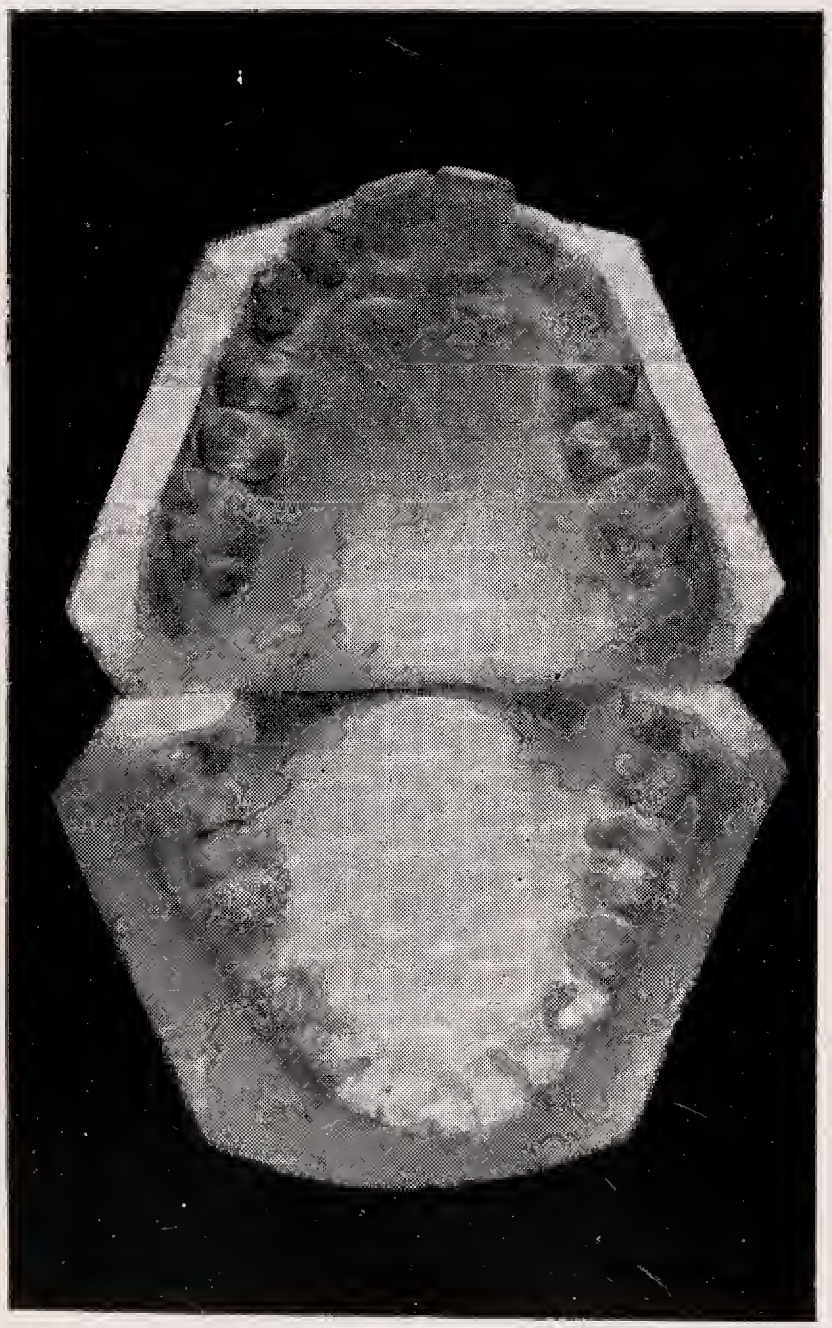

FIGURE 1.

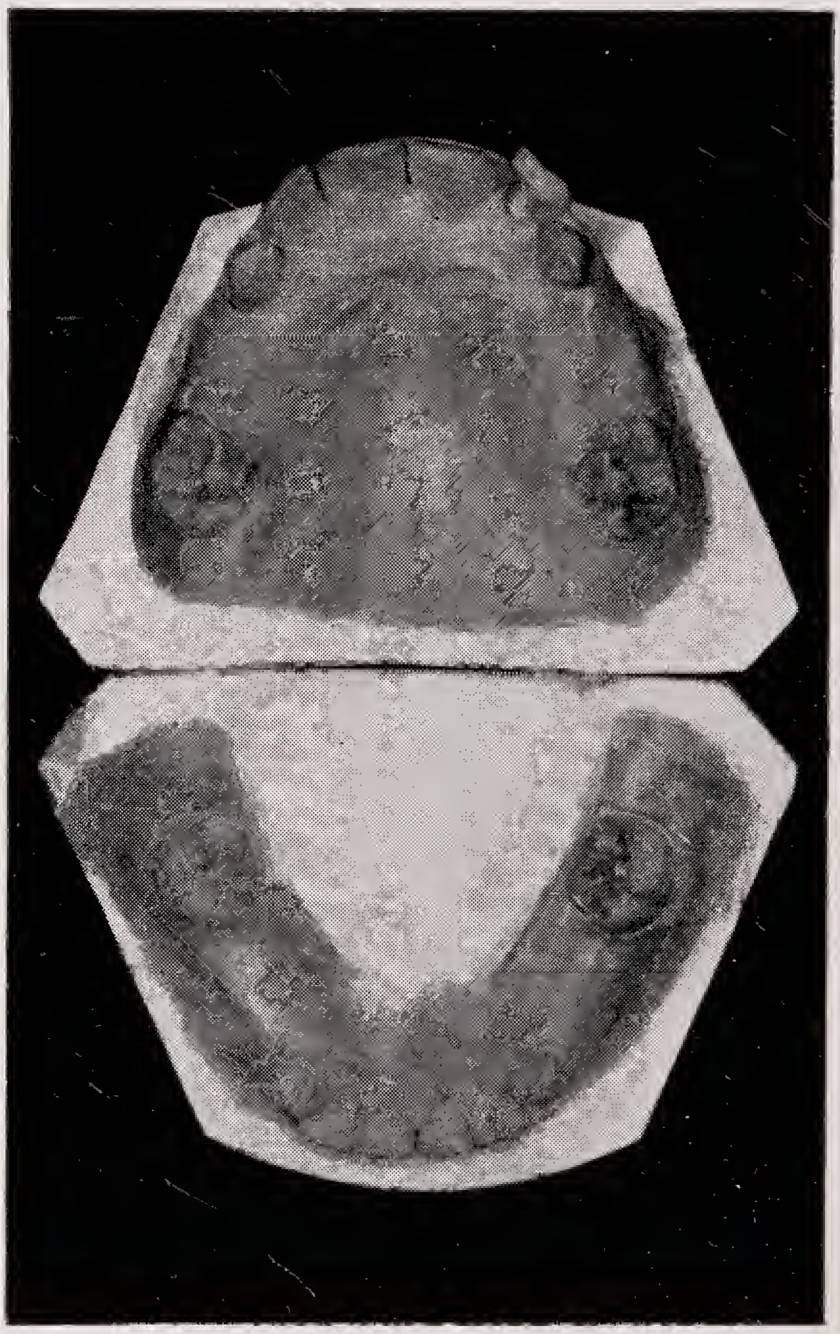

FIGURE 2.

Short Communication presented to the meeting on 12th February.

rays directed labio-lingually will not reveal to what extent these anomalous cusps contain pulp tissue, and the adjacent teeth render impossible the directing of rays medio-distally. Despite a slight concavity of the labial surface aesthetically the tooth is satisfactory. In all the cases known to me the medio-distal diameters of the crowns were normal, so that unless they were rotated or displaced the anomalous upper lateral incisors did not interfere directly with the alignment of teeth in the upper dental arch.

Occlusal interference, however, is inevitable when an incisor has a well developed lingual tubercle as the following cases will illustrate.

CASE A.

In this case the occlusal interference is manifest as a labial inclination of the anomalous upper left lateral incisor. The patient was a mouth breather.

The dental arch relation is normal and the force of occlusion of the lower incisors upon the tuber has pushed that tooth labially (figure 2). I have not seen a case in which the lower incisor was displaced from the arch while the anomalous upper incisor maintained its proper position. For that to happen there would probably need to be a predisposition to lower incisor imbrication.

CASE B.

This case (figure 3) is Mr. Endicott's. The patient was an occasional mouth breather but to a considerably less degree than in the previous case, and the lip tone was very much better. The anomalous upper right lateral incisor was not displaced from the arch, but the entire lower dental arch was displaced to a position of distoclusion with the upper. Treatment was the gradual reduction in height of the tuber, and the fitting of an

FIGURE 3.

FIGURE 4.

oral screen to be worn at night. The result after 16 months is shown in figure 4. A marked change has been brought about by a simple form of treatment directed against the cause of the malocclusion. The arch relation is not quite right because the tuber has not yet been ground down sufficiently. It would seem reasonable to spread the number of visits for the grinding down of the cusp over not months, but, as in this case, years.

CASE C.

In this case the anomalous cusp was present without the central median ridge. With eruption not quite completed, and the gingival tissues above the cervical margin of the tooth, the appearance might be that of a normal lateral incisor with a supernumerary tooth erupting immediately lingually to it. A dental surgeon attempted the extraction of the supposed supernumerary and broke off the cusp. The appearence of the tooth when the patient first presented at the London Hospital is shown in Figure 5. The tooth was vital, and the periodontium healthy, but the interesting point is that it could be clearly seen that no cornu of the pulp extended high into the anomalous cusp. There is no reason why this fact should be true of all tuberculated lateral incisors, but this case did encourage one to proceed with the slow grinding down of the cusps in the two previous cases. This case is a class II division 2 malocclusion so the labioclination of the anomalous upper right lateral incisor is probably typical. While the anomalous cusp has not contributed directly to the malocclusion its continued presence would have prevented the establishment of normal occlusion.

A fourth case that I have is a class II division 1 abnormality in which the lower incisors impinge upon the palatal mucosa without contacting the lingual tuber of the anomalous upper left lateral incisor. That is, the anomalous cusp has not been a cause of the malocclusion. It must

FIGURE 5.

nevertheless in such a case be ground very slowly away, if the arch relationship is to be corrected and the upper incisors aligned.

SUMMARY.

The cases described illustrate two occlusal effects of tuberculated lateral incisors; (a) the labial deflection of the anomalous tooth and (b) the production of a post normal relation of the lower

FIGURE 6.

dental arch to the upper. In one case there was obviously no extension of the pulpal tissue into the anomalous cusp.

The writer is indebted to Mr. C. L. Endicott for permission to show his case and to Mr. Harold Chapman for permission to show the cases from the London Hospital.

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DISCUSSION

The President said that she was very grateful to Mr. Beresford for his short communication. She had, of course, seen some cases similar to those described by Mr. Beresford, but she did not think she had seen anything in the literature about such cases or about their treatment.

She would like to ask whether Mr. Beresford thought that in Case "A" the weak lip tone had allowed the upper lateral incisor to come forward from the pressure, presumably, of the lower incisors, and whether he would expect a different result if the muscle tone in the lip was normal. The only other result that she could imagine was that the lower incisor would be moved back, and Mr. Beresford said that he had not seen that.

Miss K. C. Smyth asked whether Mr. Beresford found that the condition which he had described occurred unilaterally or bilaterally, or both equally.

(*Miss Smyth then showed Mr. Beresford models of a case in which the condition had occurred bilaterally*).

Mr. G. E. M. Hallett said that during the past year he had been investigating a number of cases of the palatal invagination which occurred in lateral incisors. Having at his disposal a large number of skiagrams which were taken as a matter of routine, he had thought that it would be a good opportunity to go through two or three thousand of them and make a clinical survey. From that survey several interesting points had emerged.

The incidence of palatal invagination was extremely high, and that had a bearing on the ultimate tooth mortality of the lateral incisor. Many unexplained deaths had been due to incipient invagination, and he had thought at first that there might be some correlation between that and the elevated cingulum which Mr. Beresford had shown. During his survey, out of some five hundred cases he had discovered one case in which there was marked elevation of the cingulum bilaterally and two cases in which it occurred unilaterally; in one of those cases there was also an associated palatal invagination. Nearly 50 per cent. of the cases showed some degree of malformation or involution of the enamel on the palatal surface, and indeed nearly 6 per cent. showed very marked involution almost into the pulp chamber.

He had one case which was very like one of Mr. Beresford's. The patient was a

thumb-sucker until the age of 6 years, and she had therefore a marked anterior open bite. She came a long way—about thirty miles—for treatment, so he put in an oral screen and the anterior open bite had now reduced extremely well, but the tubercles were fouling on the lower incisors and he was grinding them slightly each time he saw the patient, but, judging from the survey which he had been doing, he did not think there was much danger of the pulp being prolonged into the cusps.

Mr. H. G. Watkin said that he would like to thank Mr. Beresford for his communication. He had had a number of cases similar to those described by Mr. Beresford, and he thought that if the palatal cusp was ground slowly there would not be any exposure of the pulp. The pulp had not died in any of the cases with which he had dealt.

Mr. J. S. Beresford, in replying to the discussion, said he thought that, if the lip tone had been better in Case "A", the anomalous lateral incisor would not have been displaced, at any rate not to the same degree, and he felt that the effect on the lower dental arch would have been a distal relation of the whole arch. He could not prove that, but he thought it would have been so, first because he thought that the tongue would resist a lingual displacement of the lower incisor unless there was a predisposition to lower incisor irregularity, and, secondly, because in Case " B " the lower dental arch was found to be back but it came forward quickly with simple treatment.

He had seen the condition only unilaterally, but he had read that it occurred bilaterally and he was very interested to see Miss Smyth's very fine example of that.

It was encouraging and of value to him to know that other orthodontists had done a little of the grinding of the anomalous cusps and considered it to be a justifiable procedure.

Recent Work in North America as it affects Orthodontic Diagnosis and Treatment

C. F. Ballard, F.D.S.R.C.S., M.R.C.S., L.R.C.P.

The purpose of my visit to North America was to see first-hand the application of the research work which has been carried out by such men as Drs. Brodie, Downs, Thompson, Margolis, and Moyers. In the short time available it was not possible to travel farther afield than the Middle West and East, and the cities visited were New York, Washington, Chicago, Detroit, Cleveland, Toronto and Boston.

In the limited space at my disposal, I shall endeavour to give you what in my opinion are some of the most important contributions to diagnosis, and I shall link them with my own concepts. I shall also endeavour to indicate how future research is likely to make orthodontic diagnosis and treatment a scientific branch of dentistry, reducing empiricism to a minimum, and, it is hoped, eliminating it altogether in the not too distant future.

I shall assume that you are familiar with the various methods of cephalometric analysis that have been described in the orthodontic journals. The leaders in this work are Broadbent, Brodie, Downs, Higley, Margolis and Wylie.

I was told that the numerous philosophies using cephalometric analyses have many followers in the States because a high percentage of orthodontists are anxious to find a simple way of diagnosis which will obviate their having to think. In any analysis of skeletal pattern what we are really concerned with is dental base relation—whether it is normal or abnormal, and if abnormal, what is the prognosis.

Because for some years I have been attempting to find a clear method of assessing the antero-posterior relationship of the dental bases, I was favourably impressed with the method used at Northwestern. This method does not relate dimensions of the craniofacial complex to mean values, but assesses the relationship of the maxillary labial segment dental base to the mandibular labial segment dental base by comparing two angles, SNA and SNB (*Fig.* 1). The angle SNA is from the sella turcica to nasion, and nasion to the innermost point of the profile of the alveolus between the upper central incisors. The angle SNB is sella turcica to nasion and nasion to the innermost point of the profile of the alveolus between the lower central incisors. The points A and B are easy to determine on lateral radiographs (Downs, 1948).

It would be as well at this point to deal briefly with some of the variations within the normal which must be borne in mind when considering mean values. The mean value for SNA is 80·79° and SNB 78·02°, with a difference of 2·7°. This was calculated by a graduate at Northwestern in a thesis for his doctorate. The significance of the difference, however, varies as the SNA angle varies. This can be calculated quite easily. If the distance between nasion and point A is $2\frac{1}{4}''$, then with an SNA angle of 88° a difference of 6°

Paper presented to the meeting on 12th February.

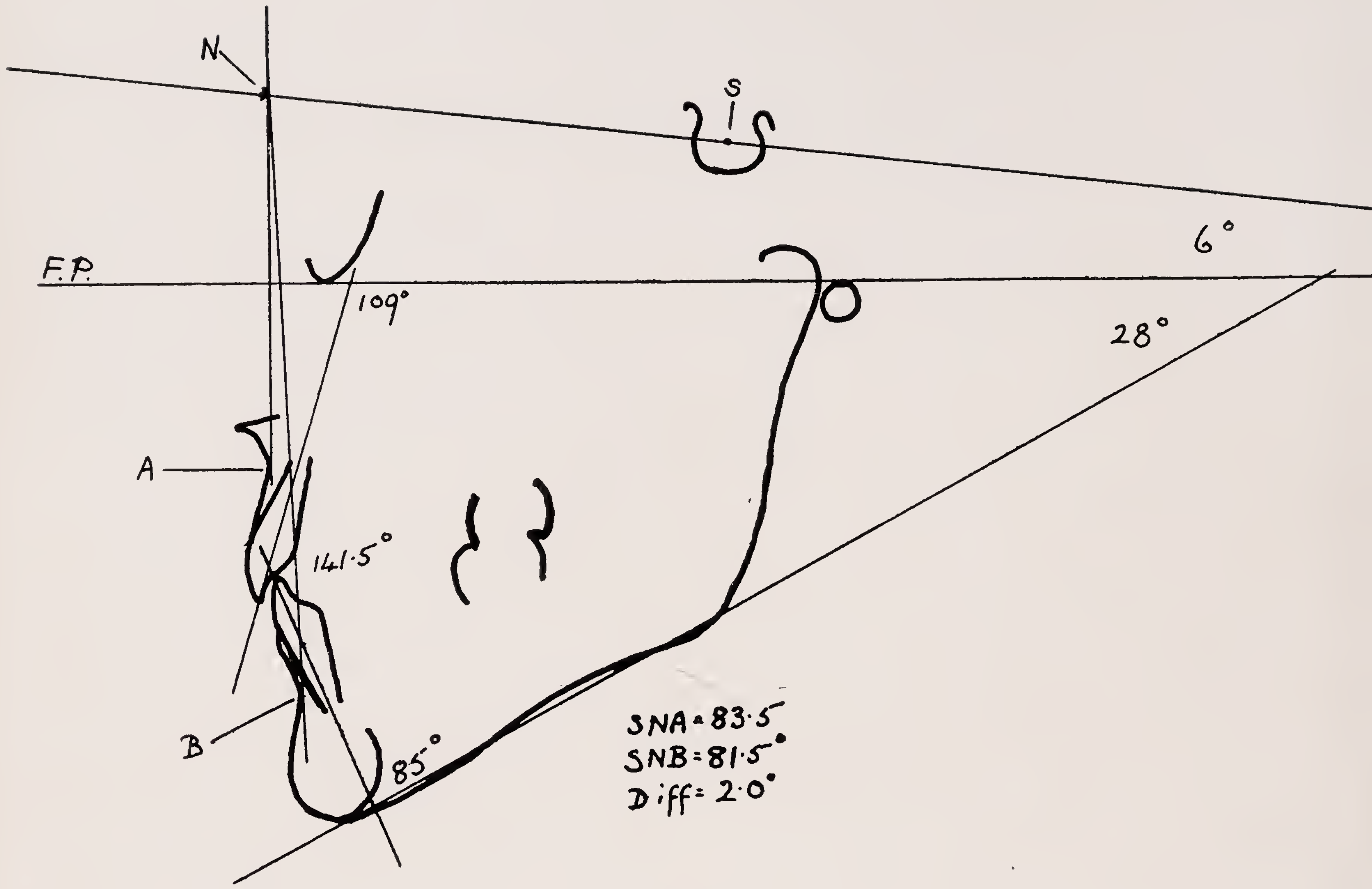

FIGURE 1.

between SNA and SNB will produce a normal incisor relationship if the axial inclination of both upper and lower incisors is within the normal. In the other extreme, with an SNA angle of 70°, then the same dental base relationship and normal incisor relationship will produce a difference of —1°.

Another important angle from the point of view of normal occlusion is that between the long axes of the upper incisors and the lower incisors. Various authors have calculated a mean value, and there is no doubt that in the majority of normal incisor relationships the angle is between 130°—140°. It is generally agreed, I think, that aesthetically the upper incisors should be labially inclined about 15° from the vertical, or 105° to the Frankfort plane. Another mean value that has been described is the axial inclination of the lower incisor to the mandibular plane, which should be 90°, plus or minus a degree or two. It is quite obvious from *Fig.* 1 that the most important variable is the Frankfort-mandibular plane angle. Therefore if we accept that facts that:—

(i) the relationship between the axial inclination of the upper incisors and the lower incisors is important from the point of view of normal overbite and overjet;

(ii) the angle formed by this axial inclination in the normal falls within range of 130°—140°;

(iii) the upper incisor has to be about 105° to the Frankfort plane for a good aesthetic result, then the angle of the lower incisors to the mandibular plane will vary inversely as the Frankfort-mandibular plane angle varies. As the Frankfort-mandibular plane angle increases, the angle made by the lower incisor to the mandibular plane angle will decrease, and as the Frankfort-mandibular plane angle decreases, the lower incisor to mandibular plane angle should increase if the other

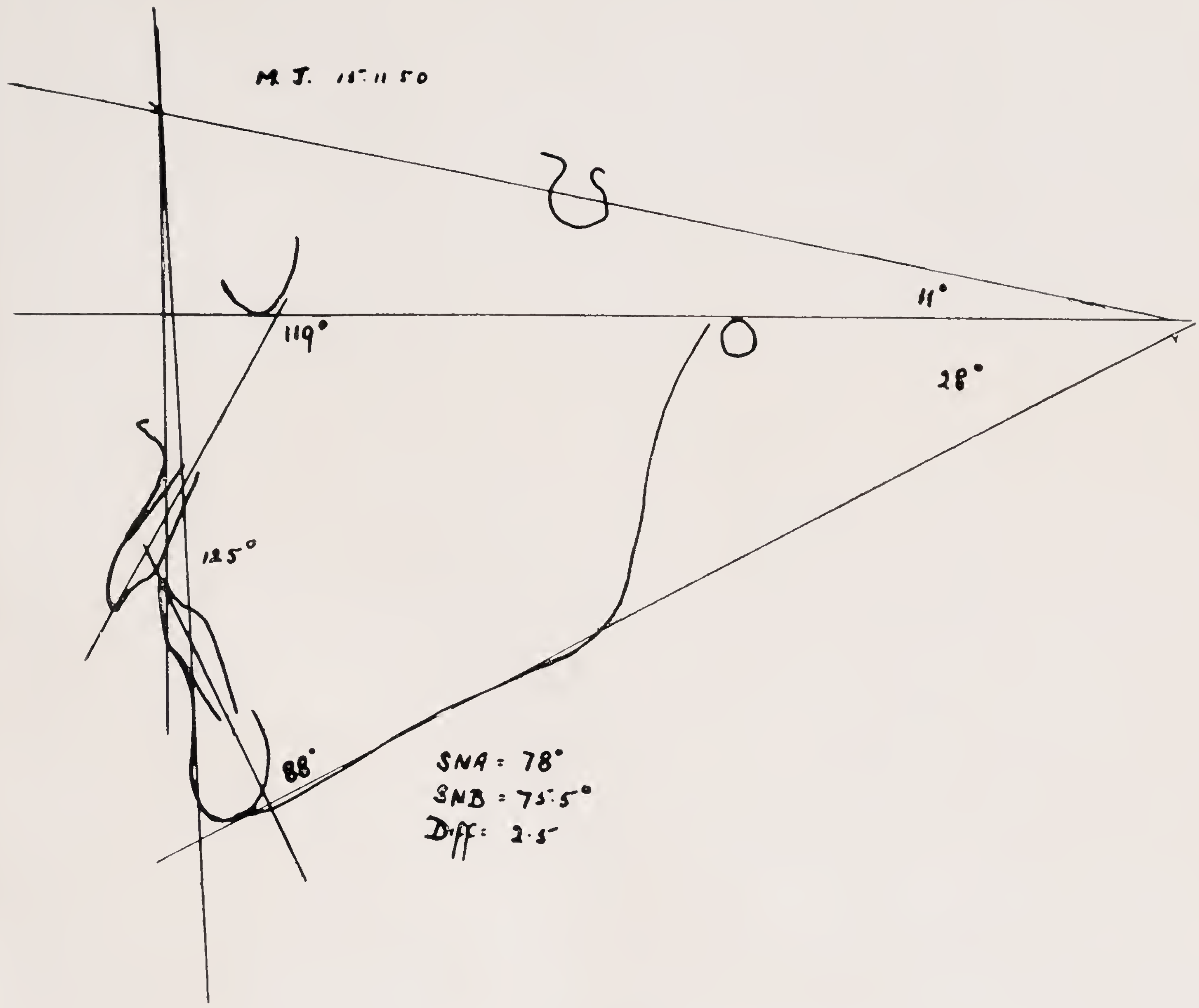

FIGURE 2.

angles are to remain within normal limits.

In the following discussion the skeletal classification is based on the analysis that I described in 1948, and is an assessment of dental base relationship from the axial inclination of the teeth.

Fig. 1: in this skeletal pattern we have an SNA angle of 83·5°, SNB angle of 81·5°, with a difference of 2°. This is ·7° less than the mean value I have given you, and varies on the side of Skeletal III pattern. The long axis of the upper incisor is 109° to the Frankfort plane, slightly proclinated from the normal. The long axis of the lower incisor is 85° to the mandibular plane. This, in relation to the Frankfort-mandibular plane angle, is slightly on the side of Skeletal III, and the third confirmation of this fact is that the angle formed between the long axes of upper and lower incisors is a little high. All these slight variations have not produced an incisor relationship which the majority of people would regard as anything but normal.

In *Fig.* 2 there is an SNA of 78°, SNB of 75·5°, with a difference of 2·5°. Note here that the incisor relationship is Class II, Division I (Angle), the upper incisors are very proclinated to the Frankfort plane, and the lower incisors are normal to the mandibular plane. Because of the proclination of the upper incisors the angle between upper and lower incisors, 125°, is small. With an SNA angle of 78°, the difference of 2·5° is within normal range, and therefore this case, although a Class II, Division I occlusion, has a perfectly normal skeletal pattern, and the prognosis should be good. The abnormality is entirely due to the muscle patterning, and that, of course, will need re-education as treatment progresses.

In *Fig.* 3 there is an SNA angle of 75·5°, SNB 68·5°, a difference of 7°, with a Class II, Division I incisor relationship. From the point of view of prognosis, the

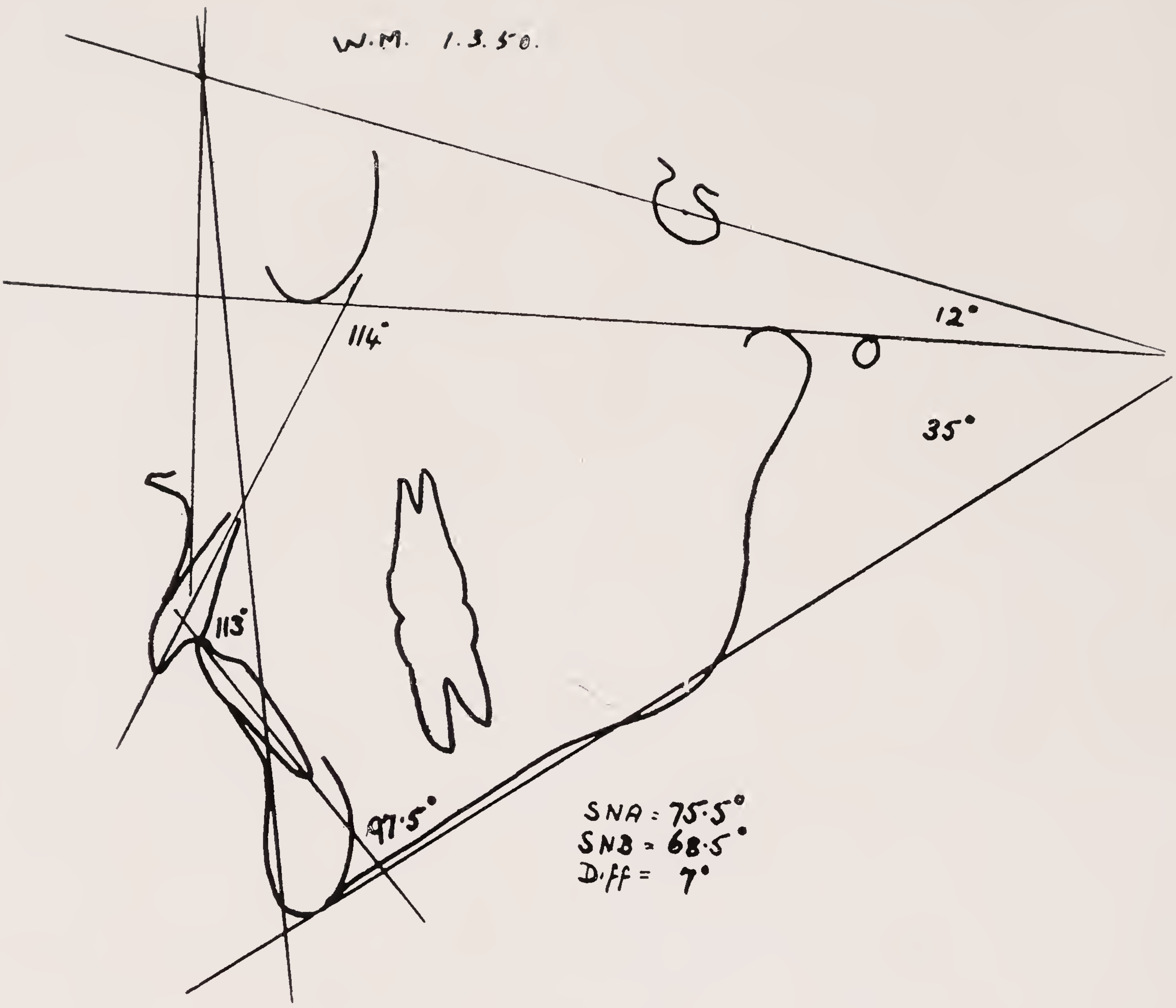

FIGURE 3.

important thing is that the difference between SNA and SNB quite clearly indicates that the patient has a Skeletal II pattern, i.e., the mandibular dental base is behind the maxillary dental base. The prognosis, therefore, is not good. However, there is one point in favour of the case. The lower incisors are at 97·5° to the mandibular plane, with a Frankfort-mandibular plane angle of 35°. This is definitely proclinated. This proclination is stable in muscle action and therefore should be left alone, as it helps to compensate for the abnormality of the skeletal pattern.

In *Fig.* 4 there is an SNA angle of 88°, SNB 76°, and a difference of 12°, Class II, Division I, incisor relationship. On an SNA angle of 88°, a 12° difference indicates a definite Skeletal II pattern. The prognosis is poor. It is impossible to obtain normal incisor relationship on this skeletal pattern. The upper incisors will be retroclinated after treatment.

In *Fig.* 5 there is an SNA angle of 89°, SNB 82·5°, difference of 6·5°. The difference of 6·5° with an SNA of 89° does not make this case anything but a very mild Skeletal II pattern, but the significant thing here is that both upper and lower incisors are extremely retroclinated in an Angle's Class II, Division 2 incisor relationship, and the prognosis depends not on the skeletal pattern, but on the possibility of re-educating muscle action in such a way that both upper and lower incisors can be tilted labially until the uppers are about 105° to the Frankfort plane and the lower incisors are about 95° to the mandibular plane. This change of muscle patterning is probably impossible, therefore the prognosis is poor,

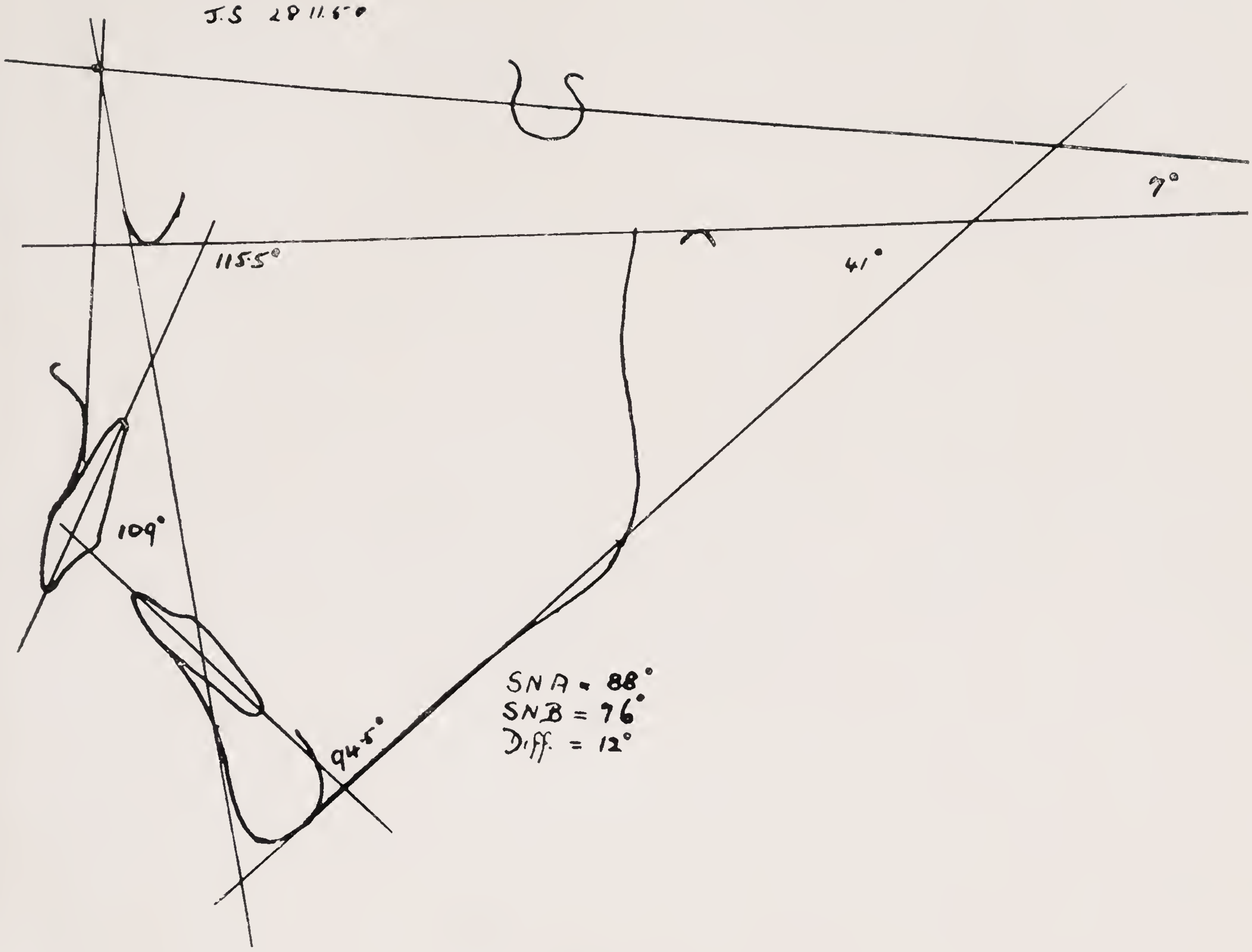

FIGURE 4.

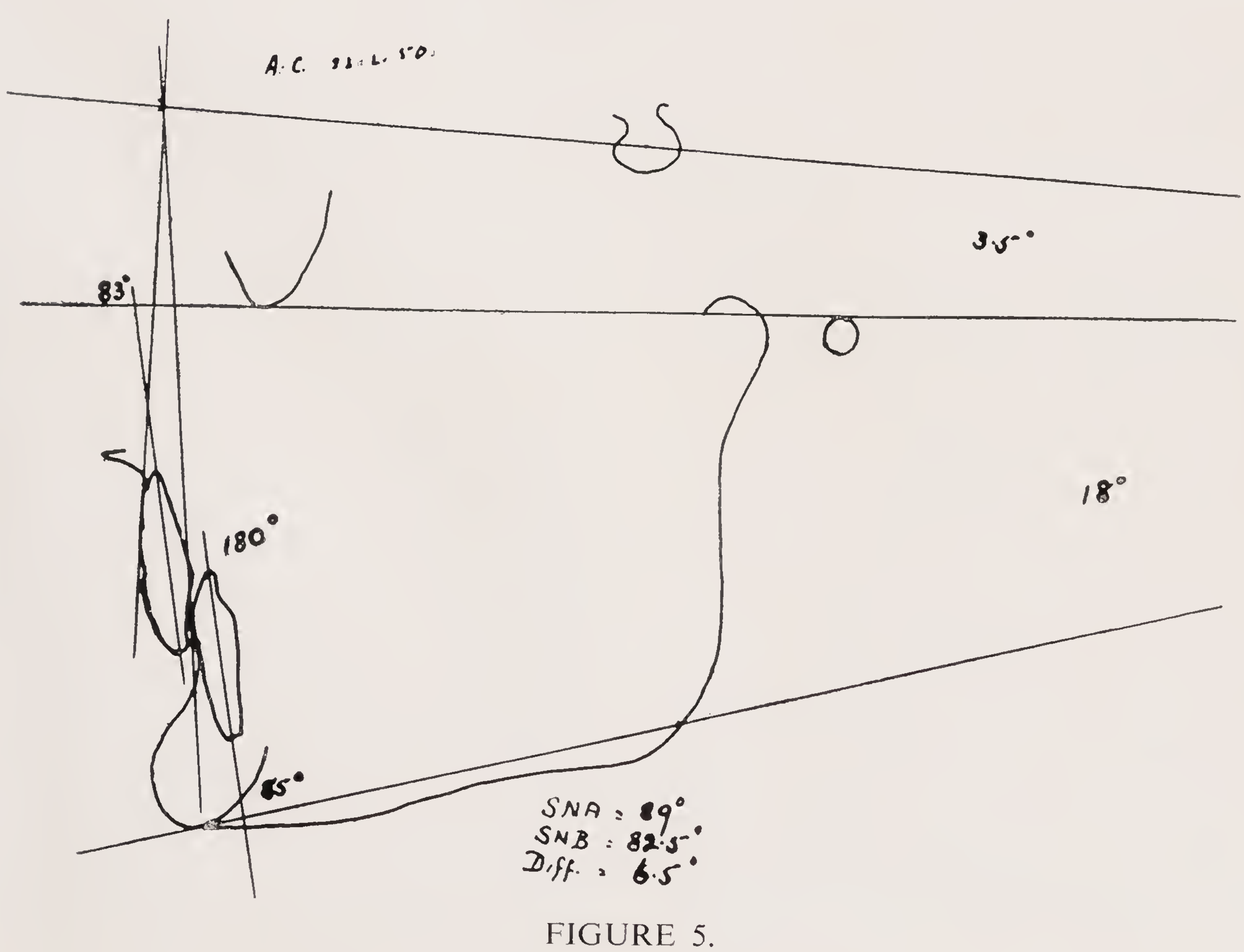

FIGURE 5.

not because of the skeletal pattern but because of the limitations imposed by the musculature.

Dr. J. R. Thomspon demonstrated to me that in spite of the limitations of this method of assessment of dental base relationship, it indicated quite clearly the skeletal pattern, and that any prognosis based on this assessment was sound.

A paper was published in the American Journal of Orthodontics, July 1950, by Johnson, called " The Frankfort-Mandibular Plane Angle and the Facial Pattern," in which further correlations were demonstrated. One of the most interesting facts which appear to emerge from his investigation is that the typical Angle's occlusal abnormalities are related to fairly definite craniofacial forms. This is, of course, supported by Brodie, who suggested that some inferior retrusions (Skeletal II patterns) are not due to mandibular under-development, but to variations in the cranial base. Another interesting point he demonstrated was that there was a significant difference in the relationship of the condyle to the Frankfort plane in typical Class II, Division I, and Class II, Division II cases. Likewise, Elasser and Wylie, in their paper " The Craniofacial Morphology of Mandibular Retrusion" relate craniofacial forms to Class II, Division I abnormalities. Finally, a very important thing to remember in using a skeletal analysis in a diagnosis is that the axial inclination of the incisors is determined as much by muscle action as by dental base relationship.

Having seen the results of treatment based on these cephalometric analyses I feel that many orthodontists in America are accepting the mean values as normals, and use the average craniofacial form which results as a template for their diagnosis and treatment. The variations of the so-called normal due to inheritance of characteristics is overlooked. This seems strange in a country like the United States of America, which must be the greatest mixture of sub-races in the world to-day. Likewise, the relationship of muscle action to the stability of the dento-alveolar structures and the labial segments in particular, is, as a rule, overlooked. The result is that many cases at the end of active treatment are unstable and retainers have to be worn for a long time.

It is all very well using a cephalometric analysis for diagnosis, but treatment can only be determined and prognosis assessed if the operator has a very clear idea as to the limitations of appliance therapy. For instance, in cases of abnormal skeletal pattern we must know whether or not the pattern can be changed by treatment, and whether it is likely to change favourably during growth. Similarly, when an abnormal muscle action is either the cause or a contributory factor, we must know how it can be changed, and to what extent.

For clinical purposes I think there are definite answers to these questions, and firstly I wish to discuss the skeletal pattern in the light of opinions and research work in America. I met no-one who believed that orthodontic treatment will change the skeletal pattern through a change of either the form of the maxilla or mandible, and this of course includes the condyle or the glenoid fossa. Because of this, an assessment of dental base relationship is very important from the point of view of treatment and prognosis. However, the skeletal pattern as assessed from lateral radiographs can be changed in certain circumstances, and it is certain that it does change to a limited extent as a part of normal growth. Small changes that occur will, I believe, be described in detail in a book which I think Dr. Broadbent is publishing in the near future. Most of these changes of growth will not affect orthodontic diagnosis, because they will not influence dental base relationship during growth. In other words, such changes would not make one modify the view expressed by Brodie that from early childhood the face grows as an unchanging pattern. However, it is quite possible that

future investigations will indicate that in certain circumstances the direction of growth of the face of an individual does change. In Down's analysis he describes the direction of growth to the cranial base as the Y axis. If during growth the angle of this axis to SN or Frankfort plane changes, then the dental base relationships change. If the angle becomes smaller the mandible must be swinging from underneath the cranium, and in cases of inferior retrusion (Skeletal II) the prognosis is better. Conversely, if the angle of Y axis gets larger, growth becomes more vertical, and if this happens in Skeletal II pattern the prognosis is bad. I believe that a certain percentage of cases will show such changes in growth direction. They are almost certainly outside the control of the orthodontist, and extensive investigation will probably be necessary before it will be possible to predict that such a change will take place in any given case.

In any analysis of skeletal pattern it is important to be fully cognisant of the work of Thompson and Brodie on the physiological rest position, and of the former on normal and abnormal paths of closure of the mandible. These studies are, of course, a correlation between the skeletal pattern and function. Thompson and Brodie show that the physiological rest position is constant for the individual, and after growth has ceased does not change appreciably throughout life. From this work I think there are two important concepts which we can accept clinically. The first is the constancy of the physiological rest position. From this position the mandible moves upwards and forwards for about $2\frac{1}{2}$mm. with an almost pure hinge movement round the condyle to centric occlusion. The space (distance) between the physiological rest position and the occlusal position (physiological?) is called the freeway space. The second concept is that in normal occlusion there is an occlusal position which is a constant for the individual. This occlusal position is the result of a balance between the force of occlusion and vertical development of the dento-alveolar structure. Any attempts to alter the occlusal position result in relapse because of the constancy of action of the musculature. However, Thompson demonstrated that certain abnormalities of occlusion are associated with abnormal paths of closure and excessive freeway spaces. He has postulated that the abnormal paths of closure are due to premature contacts and it is reasonable to assume that when there is an abnormal freeway space associated with premature contact the balance is disturbed between the vertical development of the dento-alveolar structure and the muscle forces of occlusion, and a true overclosure results. If it is true that in some occlusal abnormalities the path of closure of the mandible is abnormal, moving in an upward or upward and backward direction, then obviously the skeletal pattern as viewed with the teeth in occlusion is capable of being changed if the path of closure can be changed to the more normal one of upward and forward. The exact mechanism perhaps needs further investigation, particuarly in the light of the work of Moyers with electromyography in relation to Class II, Division, I, and Class II, Division II abnormalities. A possible physiological explanation of the mechanism of such an abnormal path of closure is based on Moyer's electromyographic observation that the posterior horizontal fibres of the temporal muscle are used for forceful reaction of the mandible, for if, at the moment when the main muscles of mastication should be relaxing there is a sensory stimulus from premature contact, then perhaps not only do the posterior but also some of the vertical fibres of the temporal muscle contract. This would not only account for the posterior displacement but also for the excessive freeway space observed in many of these cases because the vertical growth of dento-alveolar structures is balanced by the force of

occlusion at an overclosed position. The posterior displacement may only be a matter of 2 or 3mm., but this is of importance in Skeletal II cases.

The term " premature contact " is perhaps not quite correct, and it may better be called an " abnormal contact."

To reiterate, I believe that for clinical purposes we cannot change the skeletal pattern by any orthodontic treatment. I do not say that our knowledge is complete and that what I say is correct, but I do believe the diagnosis and treatment and a stable end result are more certain in every case if we commence with this concept. In the future, every piece of new evidence must be carefully assessed, and if necessary, our views modified accordingly.

Nearly everywhere I went, I had the impression that in diagnosis the emphasis was on the skeletal pattern. There was rarely any attempt to relate abnormalities of the labial segments to any specific postures or patterns of behaviour of the lips and tongue. Exceptions to this narrower approach were to be found at Northwestern and Tufts. I have already mentioned Thompson's assessment in relation to labial segment position. Dr. Margolis of Tufts is carrying out some investigations on lip pressure, which indicates his awareness of this factor as an important part of the aetiology of malocclusion. To support my observation as to the general lack of appreciation of the rôle of the lips and tongue in dental abnormalities, I should like to quote you a paragraph from Brodie's paper (American Journal of Orthodontics, November 1950):

> "The teeth and alveolar processes should be looked upon as passive though responsive victims of a continuous interplay of muscular forces, their positions dictated by the resultant of these forces. No wishful thinking about straight profiles or upright incisors, nor the most clever appliance manipulations, will serve to hold teeth in positions that are contrary to the dictates of their muscular environment. It is to be hoped that the future will find us more aware of the significance of these matters."

I believe that we in this country are more aware of the significance of these matters, and have more knowledge of types of muscle patterns associated with specific dento-alveolar abnormalities.

There is also in the same issue of the American Journal of Orthodontics a paper on the tongue in relation to dental abnormalities. Its relation to the position of the labial segment is not mentioned, and in the references the works of Rix, Whillis, and Gwynne-Evans are not quoted. I do not wish to infer that the question of such things as tongue-thrusting, etc., are not accepted in the States, but no attempt has been made so far to correlate the various patterns of muscle behaviour with any definite deformities, and the question of re-education of such abnormal muscle patterns has not, as far as I know, been discussed in any American literature.

I cannot go into any detailed description, but I felt that many cases put into prolonged retention required such retention because the labial segments had been moved into a position which was either not in balance in the original normal action, or else the original abnormal muscle action had not been re-educated.

As regards other work which is being done on muscle action in North America, you are probably all familiar with that of Moyers, Professor of Orthodontics at Toronto, which I have previously mentioned. I am firmly convinced that if he continues his research on the muscles of expression, particularly the orbicularis oris and mentalis, he is going to prove what I have contended for some years, that the incompetent lip action (the so-called adenoidal facies) is a physiological rest position and that a high percentage of such patients learn to keep their lips closed, not by exercise for the physiological rest position, but by changing their posture to a

permanent contraction of the orbicularis oris and mentalis in particular. The importance of such a conception is the difference between exercises as advocated by Rogers, and re-education as advocated by Gwynne-Evans and myself.

Fig. 6 shows a boy with incompetent anterior oral musculature, a muscle behaviour pattern which is still regarded by many people as due to adenoidal obstruction. He is not post-nasally obstructed, and there is no history of his ever being so. This lip posture is in phsyiological rest and is quite incompetent in relation to his skeletal pattern. If he is going to learn to close his lips it will be by re-education and not by exercising the present pattern. The second picture (*Fig.* 7) gives some idea of what he has to achieve. The orbicularis oris is contracted, and his mentalis extremely so. Of course, when his dental deformity has been treated such extreme contraction will not, we hope, be necessary. This sort of combination of skeletal and muscle patterning demonstrated one very important thing which must be borne in mind whenever a skeletal analysis is being made. This boy is a Skeletal II, and the only way he can comfortably close his lips is by bringing his mandible forward. If a skeletal analysis is made on a lateral radiograph taken in that position if will give quite a false impression of dental base relationship. *Figs.* 8 *and* 9 illustrate this point; the true SNA SNB difference is 7°. In the first lateral radiograph taken, the radiographer asked him to close his mouth—in other words, she wanted the occlusal position—and he closed his lips and brought his mandible forward giving an SNA SNB difference of only 4·5°, which would have led to an entirely false conclusion as to the prognosis. Such types of cases should always be borne in mind when the path of closure is being observed.

FIGURE 6.

FIGURE 7.

There is no doubt, however, that if more people had taken note of the true worth of the work of Dr. Alfred Rogers we should be much farther ahead to-day in our appreciation of the importance of muscle action in orthodontic treatment. Probably one of the factors in the failure of Dr. Rogers's concepts when applied by

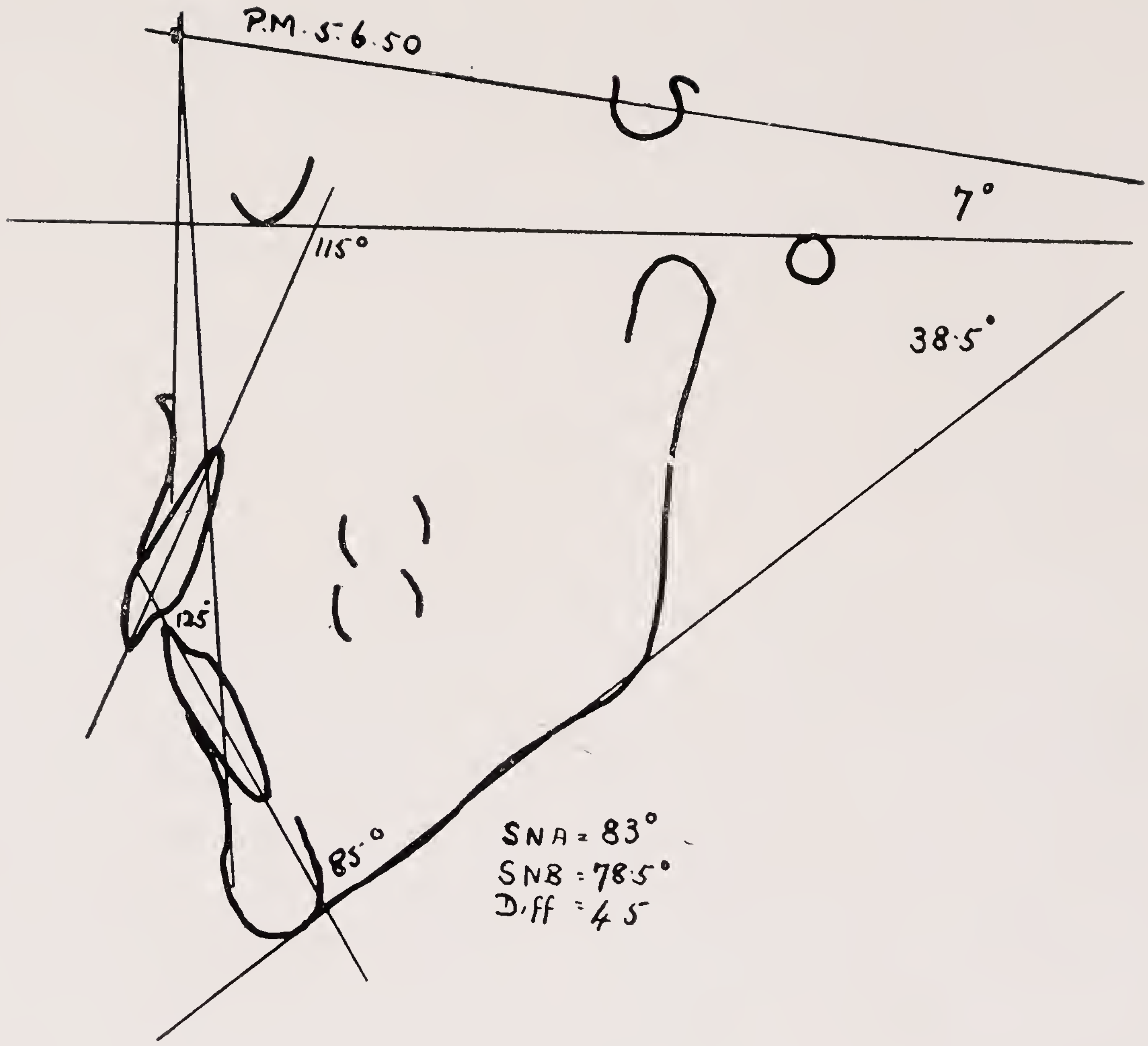

FIGURE 8.

other people lies in the fact that they had not the necessary personality. It is almost certain that Dr. Rogers's great personality so enthused both patient and parents that in a large number of his successful treatments he not only produced improved functioning of an abnormal posture, but also a change of soft tissue posture. I cannot, however, accept any contention that increased function stimulates growth.

Personally, I believe that the reason for the many concepts and philosophies which have been propounded over the last fifty years has been the result of attempts either to explain away or avoid the very high percentage of relapses which have occurred in everybody's orthodontic practice. There are still many people who believe that mouths and jaws can be developed by function to accommodate the full complement of teeth. They usually insist on prolonged retention, and even then there follows a high percentage of relapse of some degree. Such relapses have been blamed on to the inadequacy of the appliance or the lack of art of the operator. Rarely has it ever been blamed on to a failure of diagnosis, which it truly is. For instance, I believe that a high percentage of such failures is the result of lack of appreciation that the labial segments must be in balance in muscle action, and that in attempting to put all the teeth on to an inadequate dental base the labial segments are usually pushed forward into a bimaxillary protrusion position. However much the muscles are exercised, and however long this protrusion is retained, the end result is a relapse.

Apart from the question of an accurate diagnosis and from it an assessment of tooth movement required to produce the

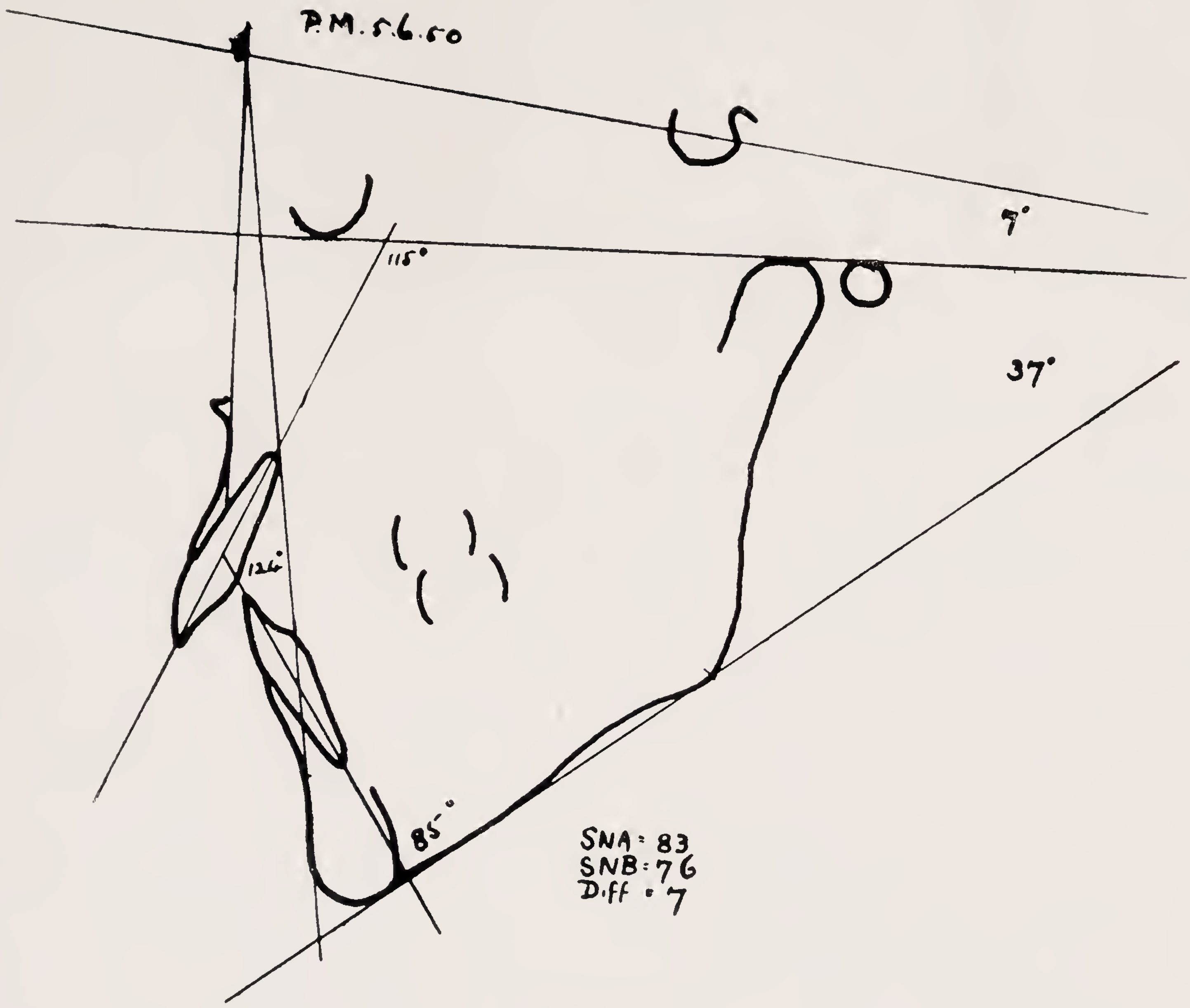

FIGURE 9.

stable end result, the double protrusions are produced because there is not sufficient anchorage within the mouth to move teeth distally. It may be that even with extra-oral anchorage the resistance of the developing posterior teeth on a short dental base is still too great. However, many unstable end results of active treatment are double proclinations or protrusions.

Tweed, whom many people regard as the greatest contemporary clinical orthodontist, realised the relationship between anchorage and unstable labial segments when he saw his double protrusions and relapses. He relates instability of the lower labial segment to its position over basal bone, which I am convinced is incorrect. The Tweed philosophy is, very briefly, the extraction of four first premolars in a high percentage of cases, and the use of the edgewise arch. The space of the lower first premolars is partly closed by forward movement of buccal segments, and the anchorage so obtained is used to bring back labial segments and move distally, if necessary, the upper buccal segments. In capable and intelligent hands I believe that this method produces a higher percentage of successfully treated cases not requiring prolonged retention than any other philosophy at present in vogue in North America. My criticism of the method is that firstly, I believe that if the same approach were modified to a realisation of the muscle action factor in stabilising the lower labial segment, fewer lower first premolars would require to be extracted, and fewer cases would finish up as slight double retrusions. I saw this principle applied in one office; the lower incisors were allowed to find their own position of balance after extraction of

lower first premolars and retraction of canines, and then the remainder of treatment consisted of building an occlusion around them. This method still results in a slight loss of functional balance because the lower labial segment is stable in a position which might be likened to the slight lingual inclination which occurs following early loss of deciduous molars or premolars in the mandible. However, the results appeared good, and not much retention was required. If the position of stability of the lower labial segment in muscle action was assessed beforehand, this empirical method would not be necessary, and the extraction of many lower first premolars would be avoided. It is in this respect that I feel we are ahead of our American colleagues. In the near future I believe that Tweed and others of his group will modify their views, and then the philosophy will not be so dependent as it is at the moment on the edgewise arch technique for closing the premolar spaces. The Tweed philosophy is finding more and more supporters because no other widely taught methods are so successful. Such earnest workers as Thompson, Margolis, Downs and Moyers are thinking on these lines, and I believe the correct balance between the non-extraction and extraction schools of thought will soon be attained by them, if it has not been so already.

My final criticism of the method is that the edgewise arch appliance requires so much surgery time that it seriously limits the number of patients that an orthodontist can have under treatment.

These are very bare facts and criticisms of the Tweed philosophy to which I could devote a whole paper. I hope I shall be forgiven for not doing full justice to this valuable work.

Summary

1. The American orthodontists in the last twenty-five years have completed a tremendous amount of valuable research work on the development of skeletal patterns, and more recently, the relationship between the skeletal pattern and the cranium. An important contribution in this respect has also come from Sweden. It is probably true to say that very little of this work that is important has not been published, and therefore we in this country should be well acquainted with the American concepts.

2. We already have considerable knowledge of the relationship between abnormal behaviour patterns of the lips and cheeks and dento-alveolar abnormalities, and some experience in muscle re-education and its relation to treatment and a stable end result.

3. Although further knowledge of both skeletal patterning and muscle patterning is necessary, it is certain that what we know at the moment enables us to formulate a logical approach to diagnosis, treatment and prognosis. Further advances will be in the nature of:—

(i) improvement in our knowledge of changes in skeletal growth direction;

(ii) better understanding of the relationship between dento-alveolar abnormalities and specific craniofacial forms;

(iii) better understanding of the aetiology of abnormal muscle behaviour patterns;

(iv) better understanding of the control and re-education of abnormal muscle behaviour patterns.

In conclusion, I must say that this visit to America was carried out with the assistance of a World Health Organisation Travelling Fellowship. I am therefore entirely indebted to them for this extremely valuable opportunity of seeing some of the most important research work related to orthodontics which has been carried out in the last thirty years, and of making so many valuable professional contacts.

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Discussion

The President asked Mr. Ballard whether all the American dental schools based their diagnosis of every case on cephalometric X-rays. It would appear that they did, but she could hardly imagine that that was so.

She felt inclined to agree that the cephalometric analysis was a method used in order to save people the trouble of thinking. That was always the danger of any mechanical aids to diagnosis. Surely diagnosis must be based on individual judgement to a very great extent, and not on angles and lines.

In referring to the angle of incisor relationship, Mr. Ballard had said that it had to be within a certain limit to be normal. But that depended to some extent on race. She remembered seeing hundreds of skulls of Lapps in the university museum at Oslo, in which the upper and lower incisors were what would be called by British orthodontists very labioclinated but the occlusion was perfect. It had been astonishing to see one skull after another with beautiful occlusion, but none of them with an incisor relationship which would fit into Mr. Ballard's angle of normality.

She could imagine that Mr. Ballard saw many cases in the United States on which he would not like to comment, but he would not have to go very far in England to see the same. She would like to know whether he thought that the average treatment in America was better than it was in this country.

Mr. D. S. Haydon-Williams said that he had been in the United States last October and had visited a number of the places which Mr. Ballard had visited. He had therefore been very pleased to come to the meeting and listen to Mr. Ballard's paper, and he was also glad that Mr. Ballard had written the paper because it would save him the trouble of writing about his own experiences.

As Mr. Ballard had said, there were universities in the United States which did not give any orthodontic teaching in their undergraduate training. For instance, at Illinois, where Dr. Brodie was, no orthodontic teaching was given until the students had qualified in dentistry, and they then had one year or sometimes two years in orthodontics. Therefore a very large number of practitioners in the United States had no idea whatsoever of orthodontic treatment or diagnosis and referred all their cases to orthodontists.

It was very interesting to find that some orthodontists in the United States (not people such as Dr. Brodie or Dr. Broadbent) were making some of the mistakes which orthodontists had made in this country and sometimes still made; for instance, believing that merely extracting teeth would produce a good orthodontic result. He had even heard an American orthodontist speak of correcting crowded lower incisors by merely removing a lower incisor. American orthodontists would find that their patients got collapsed arches, and they would have the same bitter experiences as British orthodontists had had.

An interesting point was that the films showed that all the cephalometric tracings were lateral views. He had spoken to Dr. Broadbent and Dr. Thompson about this and had said: " In your publications you point out that you can have antero-posterior views correlated with your lateral views. Why do not you use them more ? " They had replied: " We feel that there is something in the antero-posterior view that we have to learn about, and we have not yet found out what it is." The point that he wished to make was that he did not think orthodontists should be discouraged if they had not a cephalometric apparatus. If they could devise an apparatus—it was not difficult to do so—for taking a dead true lateral and taking it the same distance, and so forth, they should get excellent cephalometric tracings

without the antero-posterior view at all.

There was one point which Dr. Brodie mentioned to him and which was very interesting. There had been another swing in American opinion. American orthodontists used to preach that orthodontic treatment should be started very early, but Dr. Brodie said that at a very early age there was not enough basal bone and he deferred treatment until there was a sufficiency of basal bone; in other words, if the bone of the mandible consisted largely of alveolar bone he tended to delay treatment until there was more basal bone, even though that meant waiting for a few years. Dr. Brodie felt that if he did that the results were more likely to be permanent.

Mr. G. E. M. Hallett said that he had been very interested in the paper, especially in the development of what Mr. Ballard called the Y axis, which was new to him. The more he traced the lateral skull radiographs the more dangerous he thought it was to try to fit one's diagnosis into some rigid preconceived geometrical pattern. He had had an opportunity of studying a large number of different racial types—South African, Gold Coast, Indian, Cingalese, etc.—and he had found that there was a tremendous difference in the angles and so forth. He thought that it was safer to take one's angles from points in the skull, and that was why the Y axis interested him. It was easy to plot, for example, the nasion, and it was easy to plot the centre of the sella turcica and to plot with sufficient accuracy the Bolton point, especially if one projected the line of the spinal cord to where one would imagine that it intersected that plane, but in the case of the facial complex it was very difficult. Though in lateral skull diagrams taken from the radiographs the mandibular plane, for example, was always shown as a nice straight line, he often found that plane very difficult to put in. He found that a large number of mandibles were curved and one could take almost innumerable tangents to that curve. In order to overcome that difficulty, he took the lowest point of the symphysis anteriorly. He had noticed that Mr. Ballard used that point in some of his diagrams but in his Class II, Division 2, cases he had shown that the plane left the borders of the mandible completely and did not relate to any specific point. It must also be remembered that, with regard to the mandible, the plane was not in the mid-line, whereas the rest of the points were. He thought, however, that for checking the distal movement, for example, of the buccal segments one could relate it with some degree of accuracy to angles taken from points within the skull, notably the line from the nasion to the centre of the sella turcica.

He thought that at the moment the chief value of the work described by Mr. Ballard lay in enabling orthodontists to analyse successive radiographs. His department took about fifteen a week now and had some hundreds extending over four years. He would view with considerable trepidation any attempt at the present moment to diagnose cases by means of cephalometric analyses in place of professional acumen and experience.

Mrs. Michaelis said that she would like to thank Mr. Ballard for his extremely interesting paper. Her last visit to the United States had been as long ago as in 1938, so she felt a little old-fashioned, but it was very interesting to see how completely the American orthodontic idea with regard to extraction had changed. In 1923/24, when she had been in the United States as a student, American orthodontists had accused English orthodontists of being extractionists and had regarded the extraction of teeth as almost a penal offence, but gradually over the last twenty years they had come round to the English orthodontists' view, and Mr. Ballard had made it clear that they now extracted even more than English orthodontists did.

She believed that in the United States

orthodontics was almost entirely a speciality and that hardly any general practitioners did orthodontics, a child who required orthodontic treatment being sent almost automatically to an orthodontist. She would like to ask Mr. Ballard whether that was the case. That was not a generally accepted principle yet in this country, and orthodontics was still very largely practised as a branch of the general practitioner's work. The United States method gave a better opportunity for research work to be done, but she thought that the research which was done in this country, under much more difficult circumstances, was admirable.

Miss K. C. Smyth said that she would like to thank Mr. Ballard for his interesting paper and to associate herself with the remarks made by Mr. Hallett, with which she entirely agreed.

In connection with the President's remarks about the angle of the lower incisors in relation to the body of the mandible, it was not necessary to go so far afield as Africa, India or Ceylon, to which Mr. Hallett had referred, to find these variations in angle. She had examined Anglo-Saxon skulls of a few centuries ago and had found that the angle was completely different from what is usually considered normal. There were magnificent arches of teeth, and, although she had found many malocclusions and in her paper on the subject she had emphasised the malocclusions, there were a large number of normal occlusions, in which there was a tremendously forward proclination of the lower incisors.

Mr. W. A. Nicol said that he would like to thank Mr. Ballard for his very interesting paper and to ask him how much emphasis or how much accuracy he attached to Dr. Moyers' electromyographic work. It had always struck him that in sticking needles into muscles one was not likely to have them reacting normally, particularly in the case of such a sensitive muscle as the orbicularis oris. He imagined that the sticking of a needle into that muscle might produce quite abnormal reactions.

Mr. H. G. Watkin said he would like to add his thanks to those already expressed to Mr. Ballard.

He was glad that Mr. Ballard had brought out very clearly the action of the muscles. " Many orthodontists in this country imagine they could align thirty two teeth, but if there was not sufficient pressure from the tongue, the condition would not remain stable."

Mr. D. T. Hartley asked Mr. Ballard why the angles SNA and SNB were used rather than the angles between the SN plane and the apices of the upper and lower incisors.

The President asked Mr. Ballard why it was taken for granted that the skeletal pattern could not be altered by orthodontic treatment. The Burmese women wore collars round their necks to which they added at regular intervals, and they eventually acquired necks which were nearly two feet long. Surely they thus altered their skeletal pattern. Again, the Chinese women who bound their children's feet must surely alter their skeletal pattern in the other direction.

Mr. C. F. Ballard, in replying to the discussion, said he thought his remarks about cephalometric analysis and skeletal pattern had been misunderstood because he had made them too brief. He had tried to emphasise that he disagreed with the cephalometric analysis as a template of the normal to which the abnormal should be made to conform. For instance, the axial inclination of the incisors could not be related to the basal bone in terms of angles but had, in fact, to be related to balance within soft tissue patterning. The cases to which Miss Smyth had referred were due to the fact that a racial soft tissue patterning had produced an alveolar prognathism. The use of radiographs to demonstrate the skeletal pattern was of immense value in undergraduate and post-

graduate teaching. It was not possible in a year or eighteen months to teach thirty years' clinical experience. If, however, with lateral radiographs a logical approach to diagnosis of the skeletal factors could be formulated, and then to this be added instruction in soft tissue behaviour patterns with cinefilms, much that had in the past been purely clinical intuition could be taught within a short space of time.

With regard to Mrs. Michaelis's remarks on specialisation in the United States, he had gained the impression that specialisation was running riot, not only in dentistry, but also in medicine.

As to early orthodontic treatment, he thought there was a trend in all the dental schools in the United States that he had visited not to treat cases early but to wait until the orthodontists could be absolutely certain of their assessment of the abnormality. As a rule they did not treat cases before the age of twelve years.

With regard to preventive orthodontics, Mr. Ballard had seen paedodontists in the United States practising preventive orthodontics and doing the kind of thing which Mr. Chapman had pointed out as being entirely unnecessary because the improvement would have taken place anyway; for instance, expanding upper arches and taking out deciduous teeth because, according to their tables of shedding, they should have come out, and so on. That was what they called preventive orthodontics, and he thought it probably did more harm than good in some cases, because he personally disagreed entirely with some of the views of the paedodontists.

With regard to Mr. Hallett's remarks, he certainly did not agree that one should look at lateral radiographs as though one was looking at geometrical patterns. Orthodontists should realise that each case was an entirely individual problem, and an assessment of the variations in the skeletal pattern and soft tissue patterning must be made before a line of treatment and a stable end result could be reached. He agreed that in the past there had been many individual variations in the marking of the mandibular plane, and he thought that Dr. Broadbent's technique was the most satisfactory; that was, to take anteriorly the lowest point in the profile of the symphysis, and posteriorly the gonial point, the gonial point to be determined as a bisection of the gonial angle. This gonial point is quite obviously not an accurately determined point, but as Dr. Broadbent stressed, for serial work superimposition of the gonial angle enabled one to use the same point in each radiograph. Dr. Broadbent had found that the lower border of the mandible frequently changes its contour between the ages of three to fourteen years.

Mrs. Michaelis had mentioned the swing towards extraction in the United States. There still appeared to be two main schools of thought, one, the Tweed school of extracting in a very high percentage of cases, and the other the old Angle school, who did not extract if they could help it. The treatments without extractions were undoubtedly those that produced the bimaxillary protrusions, and these bimaxillary protrusions tended to become imbrications as soon as the retainers were left off. The orthodontists who did not extract frequently required that retainers should be worn for many years.

The specialisation in the United States had resulted in a tremendous amount of research work being done. Nearly every graduate wrote a thesis. Some of these theses were not valuable except to the writers of them, who learnt a research technique, but many of the theses were really valuable. He had not acknowledged in his paper the origin of the angles SNA and SNB, but they had in fact been worked out by a graduate at the North Western for his thesis.

With regard to Dr. Moyers' electromyography, to which Mr. Nicol had referred, Mr. Ballard hoped to do some research work on that subject in the near future.

Dr. Moyers first used an electromyograph which was designed to take readings from cardiac muscle, and because apparently the responses in this muscle were of much lower frequency than the reponses in voluntary muscle, Dr. Moyers' future work, he thought, was to be with cathode ray tubes which would show the responses in voluntary muscle much better. The fine needle electrodes inserted in the muscle did not as a rule cause any pain. If pain was present, then the immediate response to this was seen in the electromyograph, and further recordings were, of course, useless.

With regard to Mr. Hartley's question, one of the factors in treatment was the movement of the apices of upper and lower incisors. If the apices could be moved in an antero-posterior plane it was obviously no use to use them instead of the A and B points. This movement of the apices was frequently carried to extremes by the edgewise arch enthusiasts, and in many cases seen there was extensive absorption. In spite of this absorption, however, the occlusion was functionally very sound, and the supporting structures appeared very healthy.

Sequelae of Early Loss of Deciduous Molars

By E. K. Breakspear, l.d.s. Eng.

I will begin by explaining that this investigation was carried out while I was a member of the School Dental Service in Coventry, to whose Senior Dental Officer, Mr. Matthew Raeside, my thanks are due for permission to publish the material. As you all know, the School Dental Officer, even more to-day than ever, is faced with overwhelming numbers of children and is therefore compelled to extract large numbers of deciduous teeth, and this accounts for both the purpose and the limitations of this investigation.

No one would deny that early extraction produces ill effects on the permanent dentition, but the exact extent of the damage has been the subject of considerable controversy in this country. Some years ago there was published correspondence between Miss Smyth on the one hand and Mr. Townend on the other, to which some of us added our small contributions. [1] Broadly, the School Dentists pointed out that not every case of early loss showed severe abnormality in later years, and that one must try to make the best of a bad job, while the Orthodontists looked with horror on any premature extraction, and presumably were thankful that they were not called upon to perform them.

As a School Dentist myself at that time, I wished to find out where the truth lay, and if possible to determine which extractions resulted in most damage, and how the evil effects could be minimised under the conditions of the School Service, where space retainers would be out of the question for the majority of cases, and time could only be given to conserving deciduous teeth at the expense of time available for the conservation of permanent teeth. As the investigation had to be carried out in the course of normal Clinic work, an elaborate type of study was out of the question, and I decided to confine myself to the simple recording of the mesio-distal space lost, realising of course that secondary effects such as changes in the incisor overlap have been demonstrated. [2]

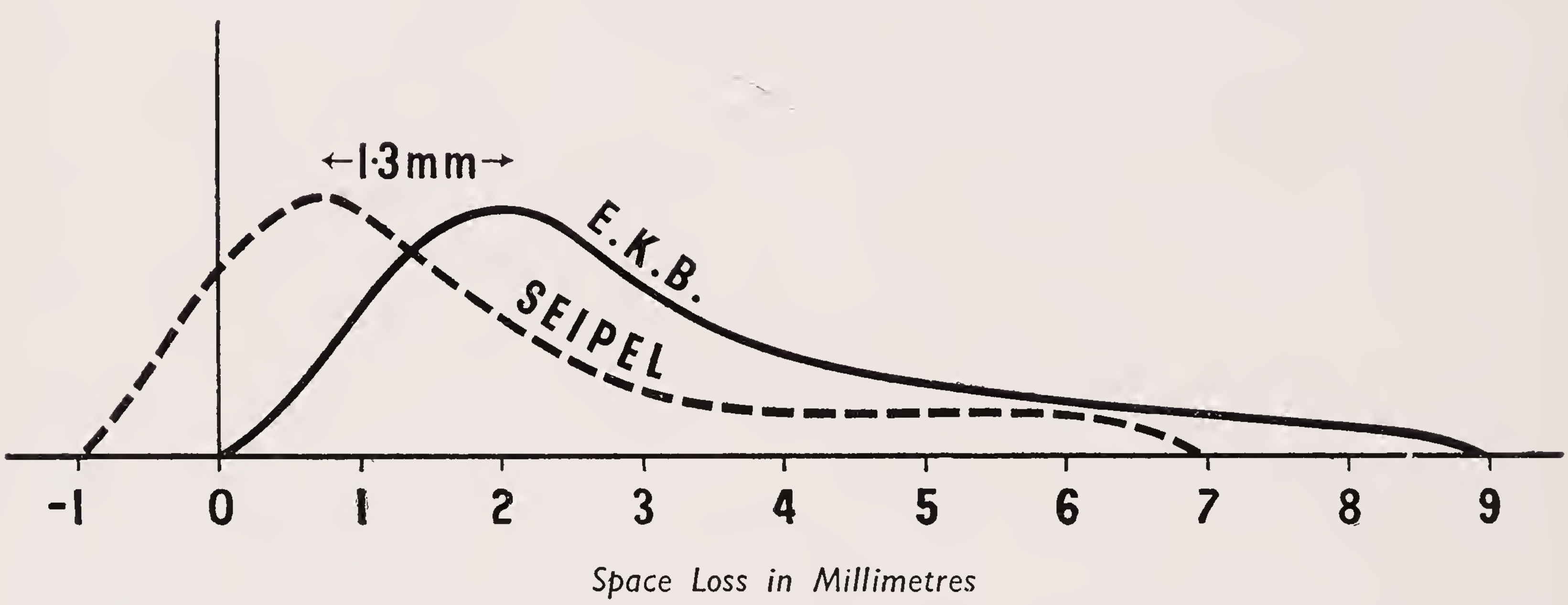
Conditions of the Investigation

The subjects were school children attending the Coventry School Clinic for routine or emergency dental treatment, for whom previous records were available. Measurements were taken in the case of children who had lost one or two deciduous molars on one side of the mouth, but who still retained the corresponding teeth on the opposite side to be used as a control. Measurements were not however taken if any of the premolars had begun to erupt in the arch under consideration. The actual difference between the two sides was noted, together with the age at the time of extraction and the period which had elapsed since extraction. Any encroachment of contact points of the adjacent tooth or the control, due to caries, was also noted. 100 cases were found during a period of 18 months in 1948-9.

Presented to the meeting on 12th March

The effect of encroachment of the contact point of the tooth extracted is discussed later. It must here be pointed out however that a true reading of the space lost by caries and extraction is only obtained when there is no additional encroachment on either side. This only occurred in 29 per cent. of the cases studied. Where there is encroachment of the control tooth, the reading of space loss will be too low; where the adjacent tooth to the extraction space shows encroachment, the reading will be theoretically too high, though it will give an accurate picture of the actual state of the arch on that side. The error introduced by ignoring these factors appears to be 8 per cent. in the case of double extractions and just under 4 per cent. in the case of single extractions. As the errors are fairly evenly distributed, they do not materially affect the results obtained, except for the figures for average yearly space loss, which should be about 4 per cent. higher than shown.

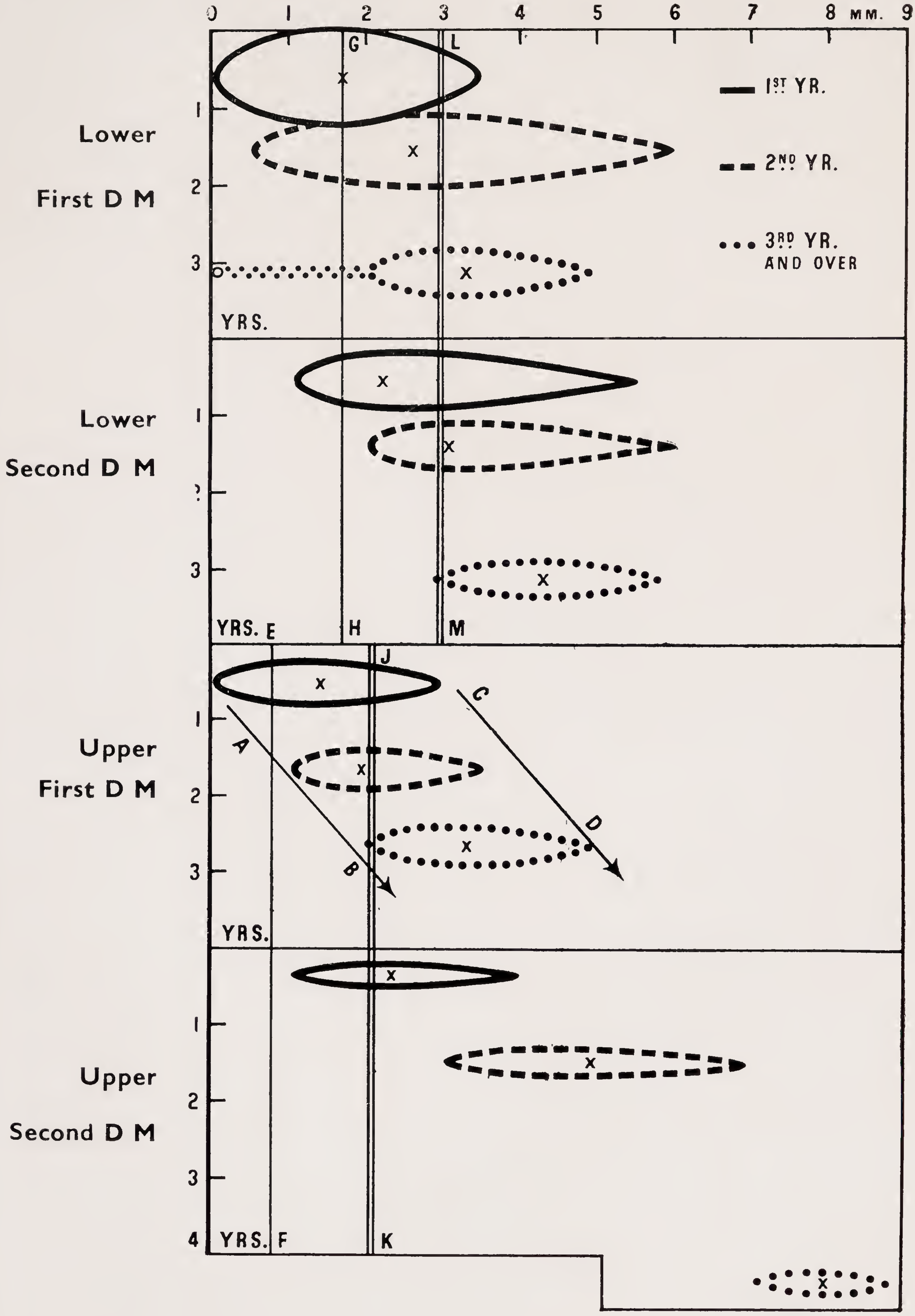
Fig. 1. Overall Result (compared with Seipel's).



Many members of this Society have worked on this subject, and I have read with interest their findings. [3, 4, 5.] I wish however to take as my starting point the work of Seipel, which has been published in Sweden and read before the European Orthodontic Society [6, 7.] The composition of his sample was not quite the same as mine, but as far as I have been able to estimate, the differences due to composition tend to cancel each other out, and after allowing for the encroachments mentioned above, the final net error is less than 2 per cent. below the true reading. For purposes of comparison, this has been ignored. I do not know whether Seipel's figures take account of changes on the control side.

In Seipel's original graph, the horizontal axis represents space loss, and the vertical axis the number of cases in the sample having space loss of the extent shown. If the Coventry curve is superimposed on Seipel's it is evident that it is roughly similar in shape, but displaced horizontally; in other words, the space loss observed in the Coventry cases was greater than that in their comparable Swedish counterparts. Ignoring any national differences, I have attributed this to the fact that Seipel took all his measurements after the premolars had erupted, while mine were all taken before the premolars appeared. This suggests that some space is regained when the premolars erupt, and as the peaks of the two curves are about 1.3 mm. apart, I have taken this as the average amount of space regained. Some of this space may of course be regained at the expense of other teeth, e.g. the canines.

FIG. 2. ANALYSED RESULT



The overall result has been broken down into groups representing the behaviour of individual teeth, and each group has been further analysed according to the period elapsing since the extraction. In order to obtain large enough sub-groups for comparison I took as my periods the first year after extraction, the second year and finally the average of subsequent years. In each case the average time elapsed has been plotted against the average space lost, and marked with a cross. It will be seen that the space loss is fairly regular, but tends to become a little slower after the second year. The number of cases of extraction of two adjacent teeth was too small to give reliable results when broken down into sub-groups, and has not been included.

Although the horizontal axis represents space loss, and the vertical axis time elapsed, the base line being at the top for each group, it was felt necessary to show the extent of the variation within each group. This has been done by converting the overall result into elliptical form and breaking it down into the appropriate sub-groups. Thus each ellipse represents the range of variation in the sub-group concerned, the vertical height of the ellipse indicating the number of cases in the sub-group. For example, in cases of extraction of an upper first deciduous molar, the loss recorded in the first year varied between nil and 3 mm.; in the second year the total loss was from 1 to 3.5 mm., and in subsequent years until the premolars were about to erupt the loss totalled 2 to 5 mm. It will be noted that the variation is considerable but not unlimited, and that the pattern of regular space loss is repeated in each group with quantitative differences. The degree of internal consistency thus demonstrated is held to justify the drawing of at any rate provisional conclusions from the small series studied. An anomalous result such as the one case where a space loss of nil was recorded in the lower D group, third year, can readily be detected, and if disregarded does not destroy the basic pattern. This was a case of prenormal occlusion, and was the only case observed where a space loss of nil was recorded after the first year.

There is of course a marginal amount of space which may safely be lost by forward movement of the first permanent molars in advance of their normal time, but which cannot be exceeded without producing crowding of the permanent teeth. Estimates of this vary widely, [8, 9, 10] perhaps because different points of reference are taken, but I have accepted Mr. Chapman's recent figures in the International Dental Journal, [11] namely, 0.75 mm. in the upper arch and 1.70 mm. in the lower. These are represented by the lines EF, GH. I have added to these amounts the space supposed to be regained when the premolars erupt, namely, 1.3 mm. if my interpretation of Fig. 1 is correct. The new critical points thus arrived at are shown by the double lines JK, LM. If this correction is accepted, the use of the graph would be as follows:

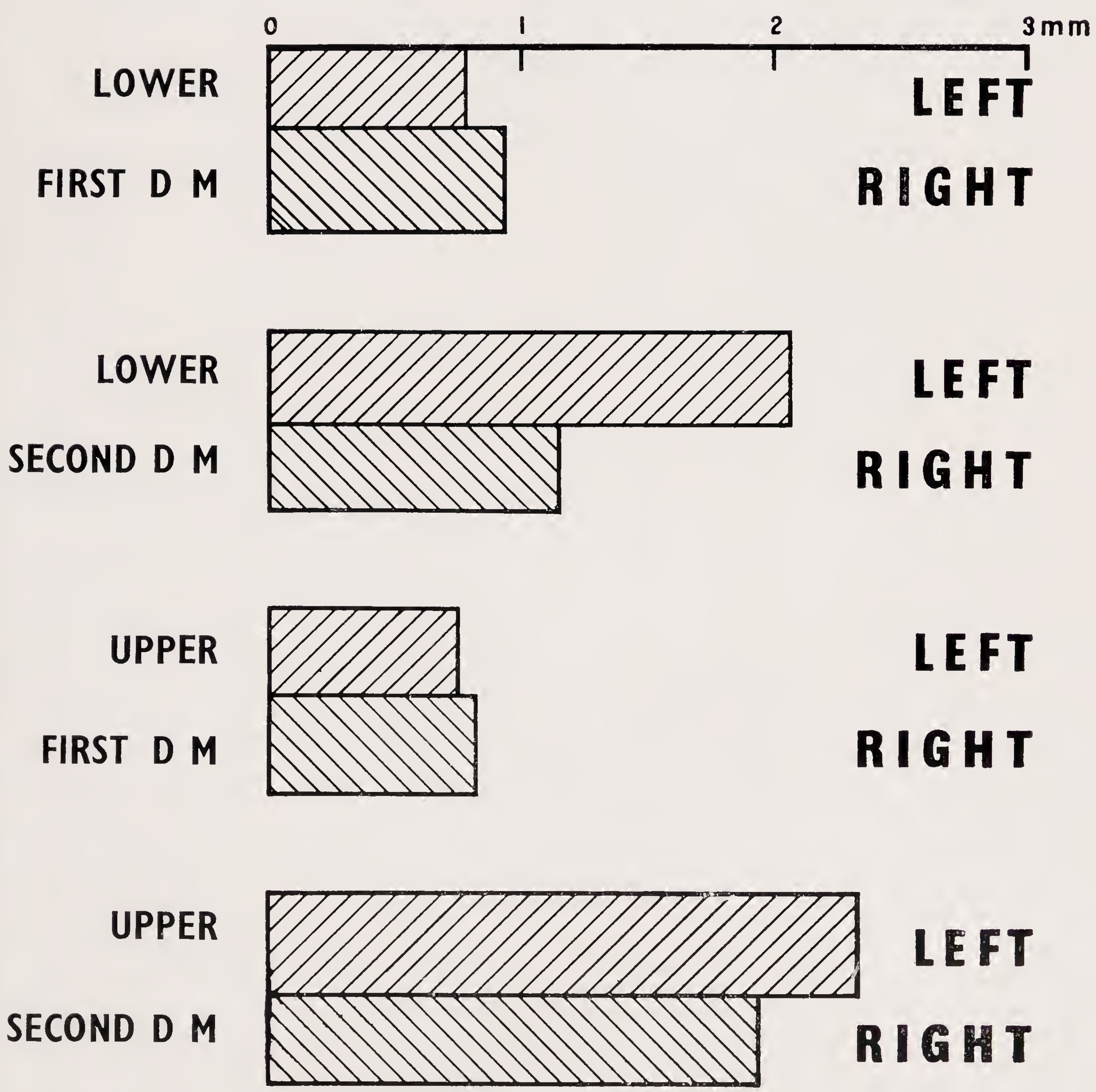
An average child losing an upper D would probably not require a space retainer for the first two years after extraction, and would only develop slight crowding if the premolars erupted soon after the second year. A well built child, who might be presumed to be less liable to lose space, would tend to follow the path AB and might never need a space retainer at all. On the other hand, a weedy child might lose the critical amount of space in the first year, if he followed the path CD. Similarly, any child losing an upper E would very rapidly lose the critical amount of space, though the final degree of crowding would be worse in one type of child than in another. It might be possible, by comparing the changes in a given case over a period with the graph, to forecast into which category it would fall and to predict its probable behaviour in the future. If that were done it would of course be necessary to eliminate as many errors as

possible by trying to determine the amount of encroachment of the relevant teeth by caries before measurements were taken.

It must be remembered that no account has here been taken of the direction from which the space is taken up. A small amount of space lost by relative falling back of the anterior teeth would be more serious in its ultimate effects than a larger loss by forward drift of the first permanent molar. Nor does a low average figure mean that a bad result may not follow in an individual case, as in the extraction of a lower first deciduous molar in a Class II case.

Most deciduous teeth are lost from interstitial caries, and this must be allowed for in computing the rate of space loss following the extraction. If the line joining the average points is produced in

Fig. 3. Average Yearly Space Loss.



(Assuming 1 mm loss by decay before Extraction)

a smooth curve, it will be found to cut the base line in the region of 1 mm. This has therefore been taken as the average amount of space lost by caries before extraction, and it has also been assumed for the purposes of calculation that the space loss occurs evenly from year to year.

Making these two assumptions, the relative rates of space loss for different teeth have been worked out, and differentiated as between left and right. It will be noted that in the case of first deciduous molars there is no significant difference between left and right, but in the case of second deciduous molars there is a marked tendency for space to be lost more rapidly on the left side. This may accord with the conception of the left side of the body as the weaker side.

In general, less space is lost after extraction of first deciduous than second deciduous molars, the highest rate of space loss being in the upper second deciduous molar group. From the point of view of the School Dentist, forced to select which teeth he will try to conserve and which he must abandon, the implication would be that if only one of two adjacent teeth can be saved in a given case, preference should be given to the second molar, unless there are special circumstances as indicated above. It is not suggested that carious first molars should be removed as a routine procedure, but the loss of a first molar can usually be regarded with more equanimity than the loss of a second molar. It is perhaps worth pointing out that the Orthodontist in hospital tends to see a higher proportion of under-developed arches than his colleague in general practice or Clinic work, and must not assume that the effects of early loss which he sees daily are necessarily typical of the child population as a whole.

The number of cases where two adjacent teeth had been extracted was not sufficient to permit detailed analysis in the same way, but two tendencies could be noted. In the first place, the space loss after double extractions did not approach the sum of the loss of the same teeth separately, but tended to be slightly less than that lost after extraction of the second deciduous molar only. If this were confirmed in a larger series, it would imply that a School Dentist who found a second molar unsaveable would often be well advised to remove the adjacent first molar as well if that were carious, rather than spend precious time on filling the first molar. The chances would be that the patient would be no worse off in the end, and another patient would certainly be better off. My tentative explanation for this, assuming it is true, is that the tongue can spread itself into a larger gap and act as a space retainer.

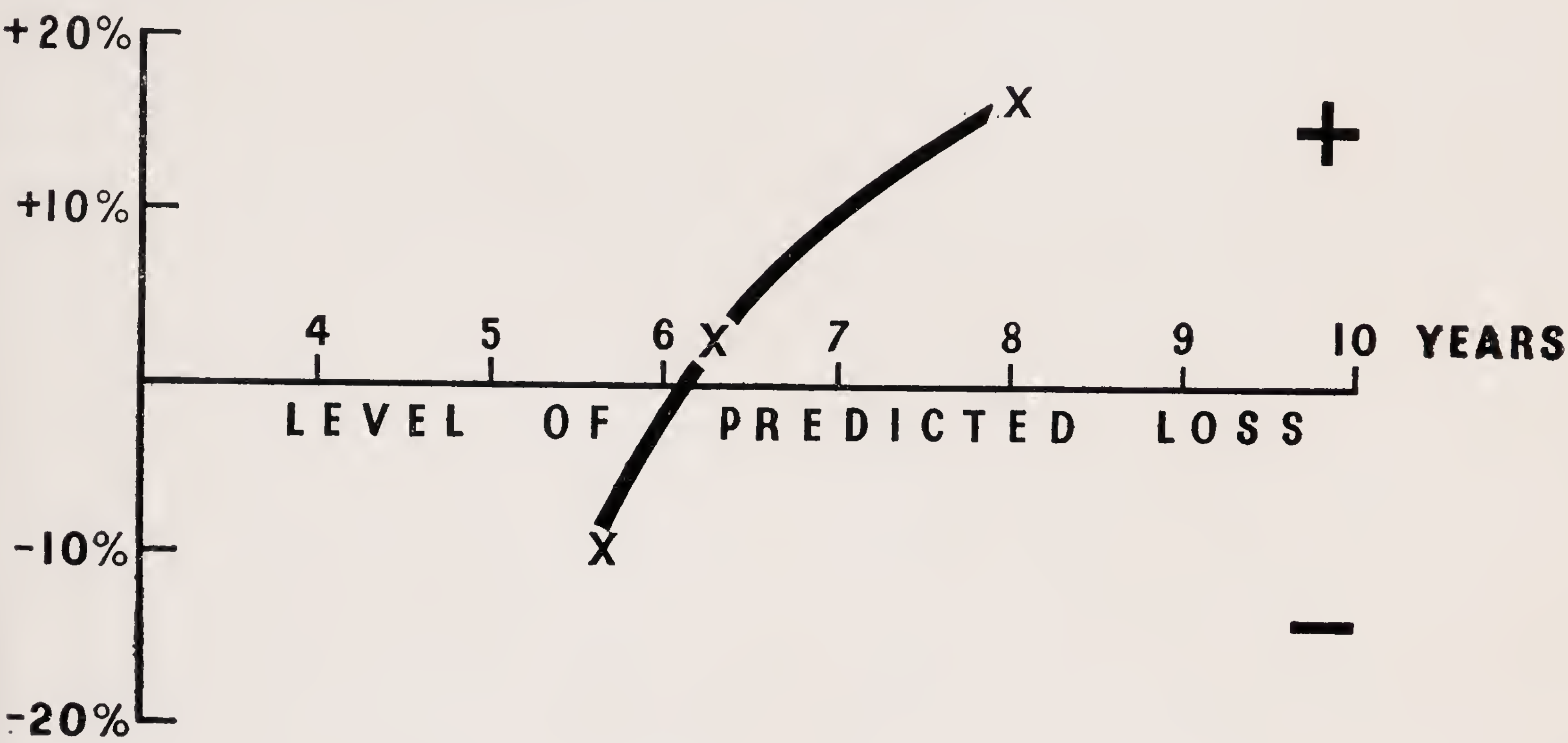
It is also of interest that in the small number of cases of double extractions, the tendency was for space to be lost more rapidly on the right side. If the nature of the influences at work after double extractions were different in kind from those operating after single extractions, as has been suggested, this difference might be accounted for. Perhaps the anatomists can help to provide an explanation of muscle behaviour as between right and left sides.

So far no account has been taken of age at the time of extraction. It was felt that in an already small series, the errors introduced by breaking the sample down into too small fragments would be greater than that introduced by ignoring a given variable on the assumption that its effect would be evenly distributed over a number of cases. One wished however to see whether the commonly held view that space loss occurs more rapidly in young patients was borne out in practice.

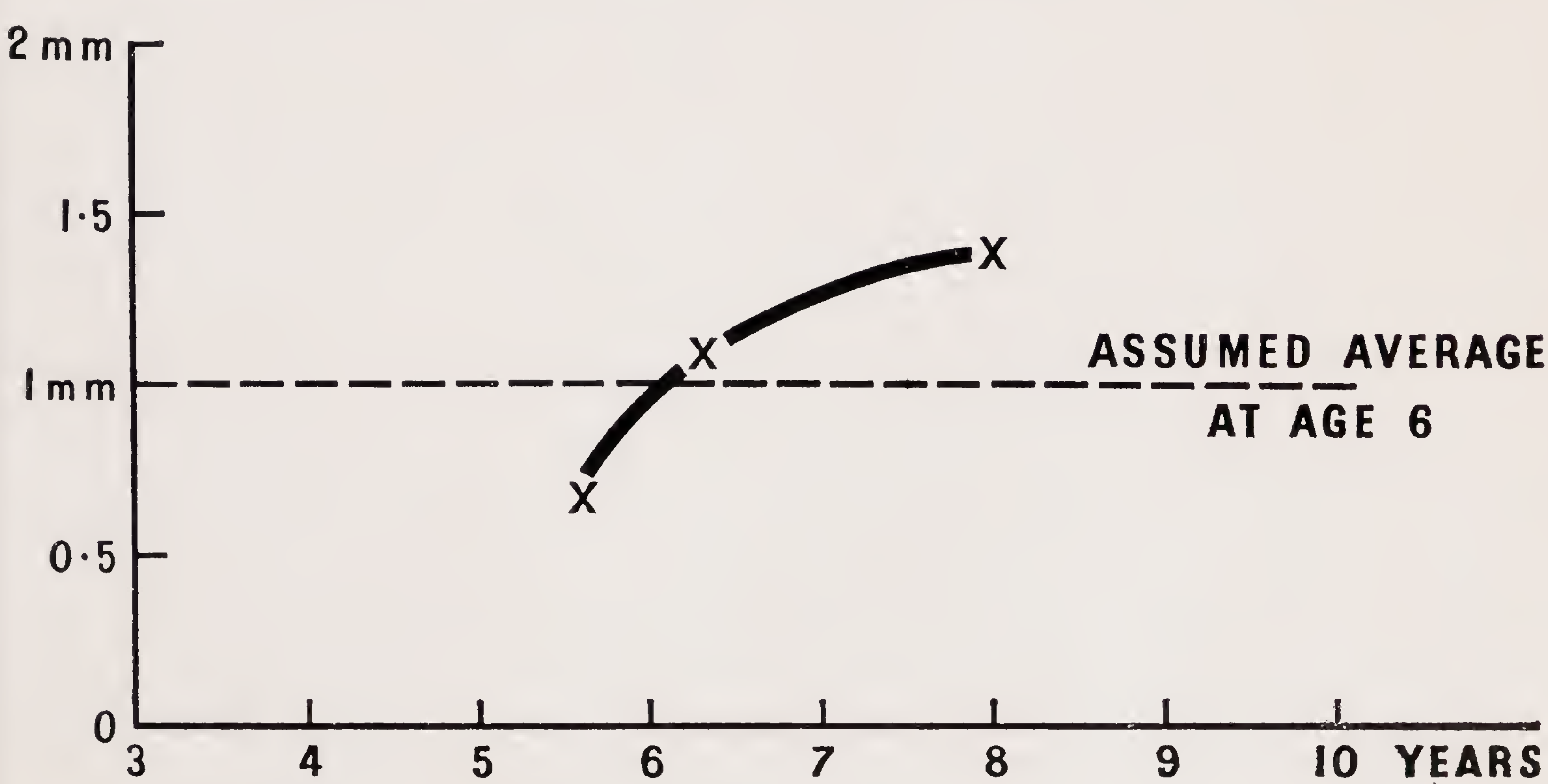
In order to do this, it was not sufficient merely to compare the average rates of space loss at different ages, as the teeth extracted at different ages were not the same; for example, there were more

FIG. 4. INFLUENCE OF AGE.

(A) DEVIATION OF OBSERVED LOSS FROM PREDICTED LOSS



(B) VARIATION IN ENCROACHMENT FACTOR REQUIRED TO PRODUCE (A)



upper second deciduous molars in the older age groups, which would tend to raise the average in that particular group. It was therefore necessary to take the cases within each age group separately, work out the predicted space loss from the results given above, and compare the total predicted for the group with the total loss observed in that group.

In order to obtain sufficiently large numbers for comparison, the age groups chosen were 5 plus, 6 plus and over 7. An under 5 series proved to be too small to be of value. The predicted loss is represented by the horizontal line, and the observed loss is shown above or below this as the case may be.

Contrary to expectations, the rate of space loss appears to be higher than the average in the older age groups, and lower than the average in the younger ages. As every known variable has been allowed for in making the predictions, the only explanations I can offer are either that there is a variation in growth during the period studied, or that the initial assumption of 1 mm. space loss due to caries is subject to an age variation. In the second graph I have shown what variation in the encroachment factor would be required in order to produce the results observed. The deviation of observed loss from that predicted varies from minus 9 per cent. to plus 16 per cent. in the ages examined, and the requisite variation in encroachment would be from minus 0.3 mm. to plus 0.4 mm. In words, the results would be explained if the average amount of prior encroachment at age 5 plus was 0.6 mm., at age 6 was 1 mm. as originally assumed, and at 8 years was 1.4 mm. I think it is a reasonable assumption that a tooth lost early in its life may show less visible decay than its comrade that lives to a ripe old age by reason of a wealth of secondary dentine, and I am inclined to accept this as the true explanation of these results. I shall however be interested to hear any alternative suggestions that may be offered.

If my supposition is correct, the rate of space loss is fairly regular within the ages studied (mainly 5 to 10 years), and the total space loss to be expected in a given case is therefore related to the number of years which are likely to elapse before the premolars begin to erupt, rather than to any intrinsic age factor.

Summary.

100 cases of early loss of deciduous molars are studied in order to determine the amount of space loss and its relation to age, position of the extracted tooth, interval elapsing since extraction, and encroachment of the contact points by caries.

Acknowledgements.

In conclusion, I should like to say that I am well aware of the deficiencies and limitations of the investigation, but I have tried to draw what provisional conclusions are possible from the material at my disposal. I wish to express my thanks to Mrs. Small of the Dental Photographic Department, Guy's Hospital, for the preparation of the photographs and slides, and to Miss J. Blackwell and Mrs. M. B. Martin for their help in the calculations and secretarial work involved.

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Discussion

The President said that it was rather difficult to discuss a factual paper such as Mr. Breakspear's, but it was very enterprising of him to carry out his investigation during his work as a school dentist. It was a very vital matter at present that an attempt should be made to determine just how much damage was being done by premature loss of deciduous teeth. She thought it important to bear in mind not only the type of child—robust or weedy—which was very important, but also the type of dentition. She asked whether Mr. Breakspear had found that more damage was done in cases of malformation than in cases of normal occlusion. It was certainly her impression that that was so, and that was why this excessive premature extraction nowadays interested the orthodontists so much. It affected the cases they saw very much more than it affected the cases with normal occlusion.

She had noted, like Mr. Breakspear, that in certain cases some space was regained when the premolars erupted, and she felt sure that was an important factor. It would explain the difference in his curve from the difference in Seipel's curve. The paper was now open for discussion.

Miss Smyth said she could not wait to add her congratulations to Mr. Breakspear for doing this work, as the President had said, in the course of his normal work as a school dental officer. She knew how difficult it was. It was one of the most practical papers ever read before the Society, and it was straightforward. It should be an encouragement to all dental officers to undertake some such comparatively simple research—if she might so describe it.

The paper was encouraging from another point of view. Evidently letters written to the *Journal* did occasionally bear some useful fruit.

Mr. Ta'Bois said that one point which had occurred to him with regard to the apparent anomaly of loss of space with age was the effect of extraction on the eruption time of the permanent premolars. He was open to correction but he thought he was right in saying that early loss of deciduous teeth very often delayed the eruption of the premolars, and if that delay could vary with the time of loss of the deciduous teeth, it might account for the anomaly. What he had in mind was this: if the deciduous teeth were lost early, the premolars might erupt more or less at their normal time, whereas if they were lost rather later—in the later age groups—the premolar was delayed in erupting and therefore there was more time for the extra space loss.

Mr. Leighton asked whether Mr. Breakspear had noticed if the opposing deciduous teeth had over-erupted in cases where two adjacent deciduous teeth were removed early. Could this impede the first permanent molar ?

Mr. Watkin thanked Mr. Breakspear for his excellent paper, and for the trouble he had taken in bringing it before the Society.

Everyone knew what a lot of damage was done by the early loss of the E's. As the previous speaker but one had said, it delayed the 5's in coming through owing to the loss of space. He knew of cases where the 5's did not come through until the age of fifteen, which was rather late. One redeeming feature was the crowding in most of these cases, and if one removed the 6's, the 5's erupted into a good position.

Mr. Ta'Bois said that another point had occurred to him. Very often when the lower E was lost the upper E over-erupted and acted as a space retainer, preventing the lower six from coming forward. Had Mr. Breakspear taken that into account in his calculations ?

The President called upon Mr. Breakspear to reply.

Mr. Breakspear thanked the Presi-

dent for her kind remarks and said that he certainly agreed that more damage was done in cases where one started off with a poor mouth or poor occlusion. It seemed to him to be a case of " from him that hath not shall be taken away even that which he hath ! " He was glad that the President confirmed his deduction that some space was regained when the premolars erupted.

He thanked Miss Smyth for her encouraging remarks. They had crossed swords on paper in the past, and he had expected a verbal duel now. He was glad she was on his side that evening. He would like seriously to underline her remarks about the need—and not only the need but the possibilities—for research in the school dental service. The very thing which made the school dental service unattractive—that one had to deal with large numbers of children all wanting the same thing—was an opportunity to study large numbers of cases and see what happened when one did that thing. The ordinary man in practice could not deal with large numbers of cases all having the same particular treatment done, in the nature of his practice. In hospital one never got a fair cross-section of the child population as a whole. There was a unique opportunity in the school dental service, and he hoped many people would take advantage of it. It was one of the factors that made the service more interesting than it would otherwise be.

Mr. Ta'Bois had asked about the effect of early loss and late loss on the eruption of the premolars. He was not quite sure that they were talking about the same thing. In the first place, all he knew about it was what Mr. Schachter had said in his paper in 1943—that if the tooth taken out was a septic one the premolar had less hard bone to fight its way through. Anyway, the premolar was supposed to come through a bit earlier.

On the other hand, if a live tooth were taken out, the premolar was likely to be delayed. He did not know whether that had any bearing on the matter, but unless he had understood the question wrongly he thought it worked the other way round, because he had found that the earlier the extraction the less the apparent rate of space loss. The result might be worse in actual fact, but the rate of space loss was apparently slower, and he thought the speaker's remarks would tend to operate in the other direction. He would gladly take a supplementary question, however.

In reply to the question about the over eruption of the upper E's, he said that sort of effect did happen. Many people, including Miss Smyth and Mr. Chapman, had shown cases of that kind. It was a well-known phenomenon. He had not taken any account of why or how the space was lost or not lost. He had merely recorded the fact, in a large number of cases. The practical point was that one could rely on its happening. In a fair number of cases, it was safer to take out that tooth than it would otherwise be.

What he had been trying to find out was the general effect of policy on a large number of cases without regard to individual distinctions.

The same applied to double extractions. He was glad that the point had been raised. It might be the other teeth which were holding the first molars back.

Finally, he agreed with Mr. Watkin that one could remove the sixes, and in many cases, even in the school service, one had to because one had no time to follow them up. But in general he preferred to keep his sixes and take out something else. He felt that once one had taken out the sixes one had lost control of that mouth. He thanked Mr. Watkin for his remarks.

The effect of the Condyle on the growth of the Mandible

A. J. Walpole-Day, B.D.S. (Birm.) H.D.D. (Edin.) L.D.S. (Eng.)

In the study of the growth of the face or jaws it is convenient and desirable to consider it in relation to the stability of the cranial base. Convenient, because both jaws are attached separately to the cranial base and desirable because the cranial base separates the face from the cranium which grows at a different rate. The newborn cranium increases four times in size by adulthood and the face grows three times as much as the cranium. Of the increase in size of the cranium more than three-fourths has taken place by the age of seven years, but even during this time of rapid growth, the face is growing at a greater rate than the cranium and it continues to grow until the twentieth year([1]).

Considered in relation to the cranial base the face grows forward and downward in a more or less steady and orderly manner. In the upper jaw this forward growth is brought about by growth at the sutures which are all arranged to slope downward and backward, ([8]) by growth at the free surfaces particularly in the alveolar region and by the succession of permanent teeth which are developed in the retro-molar region and cause a forward migration of the teeth anterior to them.

In the lower jaw, Wilson Charles([3]) has described two processes taking place at the same time, namely the growing condyle pushing the body of the mandible downward and forward while the body itself grows upward and forward around it. Brash([2]) has shown that little growth occurs in pigs on the lower border of the mandible and the main increase in height of the body is due to addition to the alveolar border and there is ample clinical evidence that a similar process occurs in man.

The growing condyle is developed from an accessory cartilage which appears at the end of the third month or a little earlier.([5]) This cartilage is quickly ossified by being resorbed and replaced by bone, except in the region of the condyle where it persists. This cap of cartilage grows rapidly during the early years, by the apposition of chondrocytes on its surface which are derived from the fibrous layer which is the outer covering of the condyle.

Rushton ([6]) describes four layers in the surface of the condyle. Starting from the joint cavity they are: a fibrous layer, a layer of closely packed small cells, a layer of fibrillar cartilage and then marrow and bone. In the foetal and very young mandible the cartilagenous layer is not clearly defined from the bone, and on section areas of cartilage and bone are found together as the cartilage is being absorbed and replaced. Rushton ([6]) also states that " the appearance of the condylar head suggests extreme fragility and its susceptibility to crush-injuries in early youth is not surprising."

Fig. 1, a and b, shows an X-ray of a foetal mandible toward the end of the fifth month. The carrot-shaped area leading into the body of the bone from the condyle is the track left by the growing

Presented to the meeting on 12th March.

FIGURE 1(a)

FIGURE 1(b)

condyle and consists in section of a cap of cartilage under which is an area of bone spicules and absorbing cartilage and deeper still an area of newly formed bone spicules.

Fig. 2 shows photomicrographs of a foetal condyle.

(a) Low power view of whole specimen.
(b) Rapidly growing cartilage from the cap of the condyle and
(c) Absorbing cartilage and newly formed bone from the area under the cap.

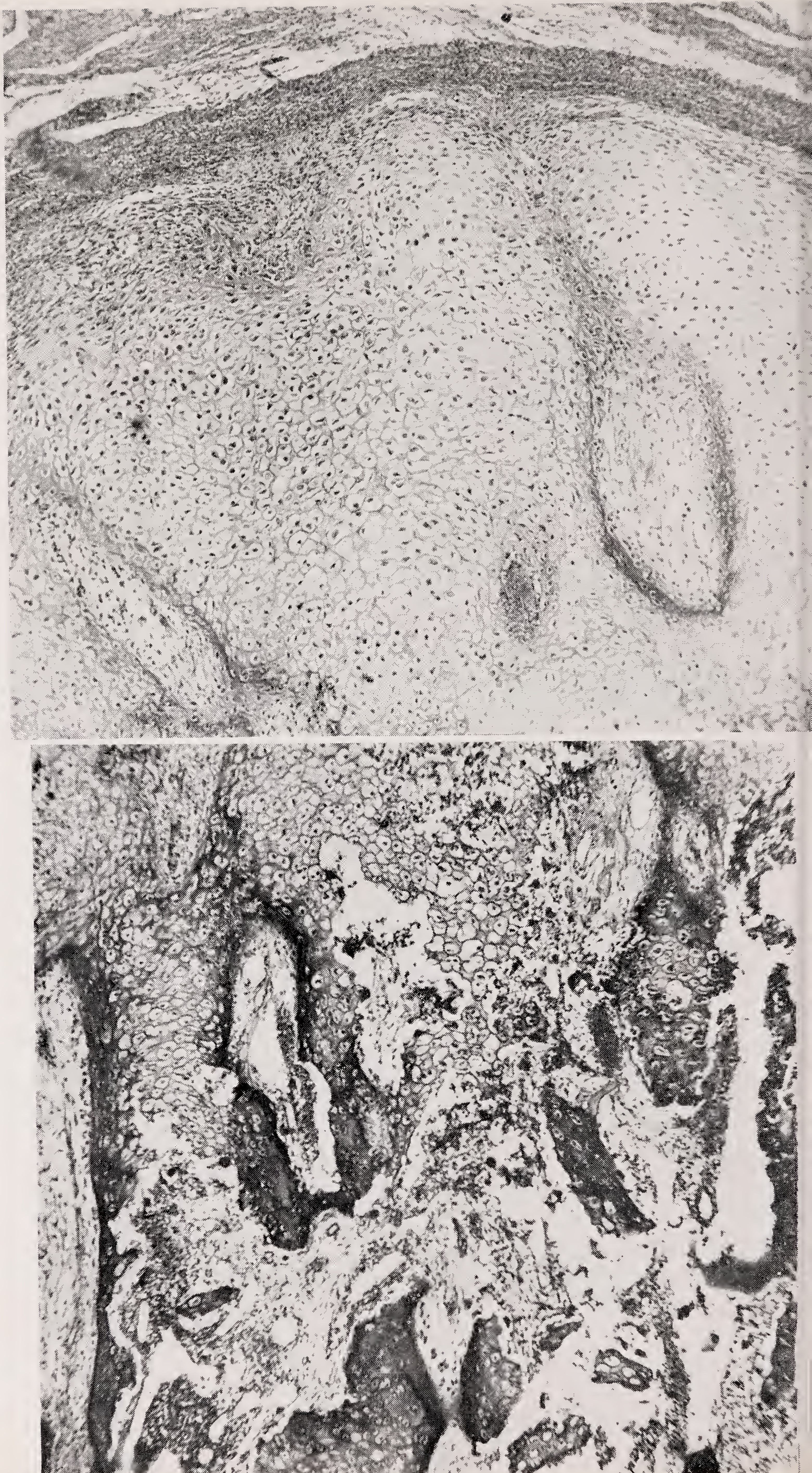
The growth of the condyle is extremely

important because not only is it responsible for a great increase in length of the mandible but the wedge of bone formed from it forms the framework on which surface additions are made to form the ramus and to some extent the body of the mandible.

As both jaws are attached to the same base and as the lower jaw encloses the upper one it is obvious that the vertical growth of the lower jaw must be equal to the sum of the vertical component of the upper jaw suture growth, the vertical growth brought about by the development of the upper alveolus and the eruption of the upper teeth and the increase in height of the body of the mandible brought about by the growth of the lower alveolus and the eruption of the lower teeth. The total vertical increase in height of the mandible is brought about by the growth of the condyle because very little growth occurs at the lower border.

In addition the angle of growth of the condyle must allow for sufficient forward

FIGURE 2(a)



B.

FIGURE 2

C.

growth of the manidble so that it keeps pace with the forward growth of the maxilla.

To what extent the inclination of the condylar growth is responsible for the forward displacement of the body and how much forward growth is produced by the growth of the body of the mandible and the teeth it contains is not yet accurately determined but it seems that the condyle is responsible for considerably more than half of this growth.

It is obvious, therefore, that the growth of the condyle is the most important single factor in the co-ordination of the growth of the two jaws to produce a normal occlusion of the teeth. If there should be any doubt about the importance of the growth of the condyle it will be quickly dispelled by an examination of the six cases illustrated, which show what happens when a growing condyle is injured.

Case 1 (Fig. 3). Miss M.S. (age 13 years) shows the effect of a bi-lateral fracture of the condyles at birth. This girl was the third child of six, all the others being normal. The birth was difficult being a breech presentation and the fracture occurred presumably during the delivery of the after-coming head by jaw and shoulder traction. The X-rays show that the ramus is very poorly formed and there is an acute bend in the region of the neck of the condyle.

An unusual feature of this case is that the lips can easily be closed and there is normal nasal breathing. This condition exists as a result of a considerable effort on the part of the patient which has caused the mentalis muscle to be particularly well formed so that it looks like a chin. The actual chin is the slight rounded prominence between the mentalis and the neck.

Good opening is possible but there is no lateral movement, the articulation is quite efficient although the lower incisors are almost horizontal.

Case 2 (Fig. 4). Miss S.R. (age 10 years) shows the effect of destruction of

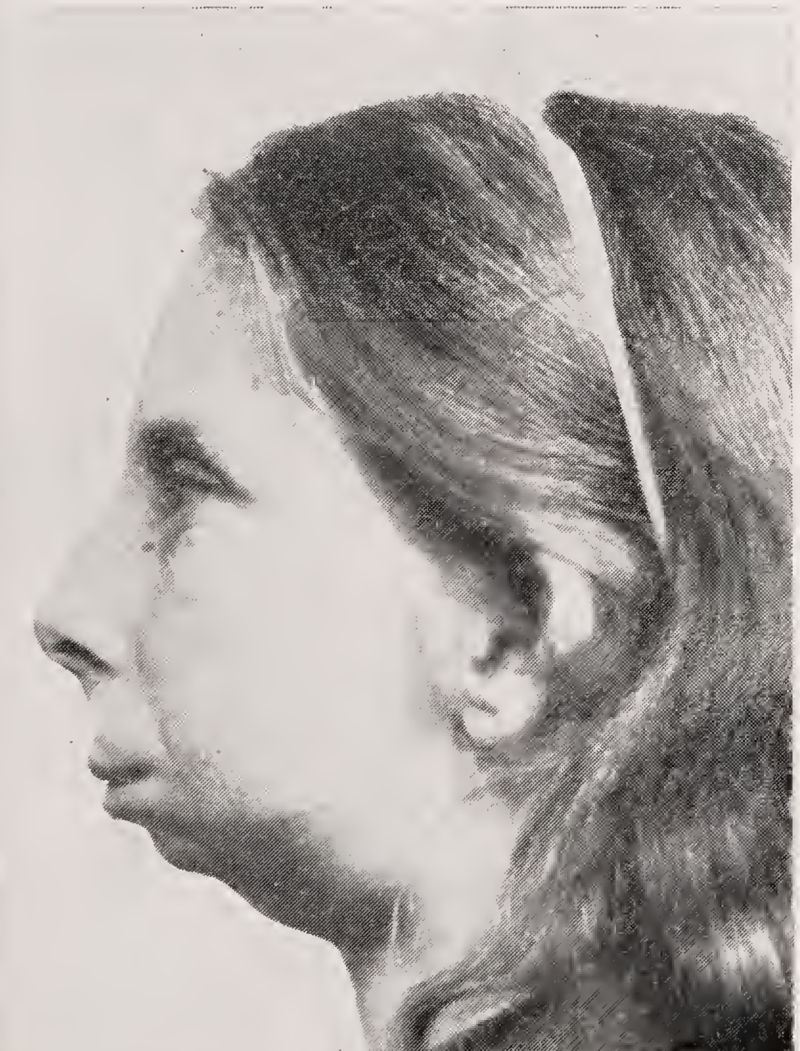


FIGURE 3

FIGURE 4

the left condylar cartilage at the age of twelve months. The condition is the direct result of septicaemia following an infection of the toe nails when the child was a year old. Whilst the child was in hospital there was much swelling of the face and neck, and mumps was suspected for a time.

Supraclavicular drainage was applied on the right side only.

Other diseases include measles as a baby, scarlet fever at five years and earache recently. The mandible deviates to the left side on opening and no forward movement of the left condyle is possible. X-rays show normal right condyle and complete destruction of the left condyle and obliteration of the joint.

The mandible is underdeveloped particularly on the left side where the ramus is very short. The lower arch is very post-normal and the lower centre deviates to the left by the width of a lower incisor.

Case 3. (Fig. 5). Master J.W. (age 10 years) shows fibrous ankylosis of the left condyle following an abscess which appeared in this region and was lanced at the age of eighteen months. No abnormality was noticed by the mother at first except that the child had difficulty in " forcing " food into his mouth.

The family doctor was the first to comment on the child's appearance at three years of age. He referred the patient to Mr. Sankey who advised a left condylectomy. He was admitted to hospital at the age of nine years at which time the opening of the mouth was reduced to 0.4 c.m. A post-auricular incision was made, the ear being reflected downward and forward. The condyle was divided with a dental bur and a strip of temporalis fascia placed between the bony surfaces to produce a false joint. A week after the operation the patient was given an acrylic screw to open the bite. This he used so conscientiously that he had to be requested to curb his enthusiasm. The opening possible a year after the operation was 2.0 cms.

FIGURE 5

The appearance in this case is similar to case 2, there being a marked deviation of the chin to the affected side and the mandible being poorly developed on this side particularly in the region of the ramus. The articulation of the mandible is very post-normal but the centre line of the teeth is better than in case 2 because the loss of $\overline{6}|$ has allowed a drifting of the lower incisors to the right.

Case 4 (Fig. 6). Miss P.S. (age $13\frac{1}{2}$ years) shows fibrous ankylosis of the right condyle following pyaemia after a tonsillectomy at the age of eleven years. Two weeks after the tonsils had been removed pyaemia developed and swellings over the left mandible, elbow and right knee had to be drained. No drainage was applied to the affected side of the mandible. The deformity was first noticed about six months later. There is now marked deviation of the mandible to the affected side which is more noticeable on opening the mouth. No forward movement of the right condyle is possible and opening of

FIGURE 6

FIGURE 7

the jaws is restricted to 1.8 c.ms. The articulation of the mandible is post-normal and the lower centre deviates to the right by the width of a lower incisor.

Case 5 (Fig. 7). Master J.F.C. (age 9 years) shows asymmetry which is associated with over-growth of the right condyle. The deviation of the chin to the left side is very marked as the boy closes his mouth but disappears on opening widely. This boy fell on a fender on the right side of his face at twelve months and had measles at eight years of age. At this time the doctor remarked on his appearance and suggested partial facial paresis.

Clinically there is good range of movement of both condyles and the right condyle is more easily palpable than the left. On X-ray the right condyle appears larger than the left.

In the two years that have elapsed since the photographs were taken some orthodontic treatment has been given to cure the cross-bite on the left side. The bite is now quite free but the patient has great difficulty in bringing the lower centre over to correspond with the upper. The appearance is a little improved.

Case 6 (Fig. 8). Master J.C. (age $10\frac{11}{12}$ years) shows considerable facial asymmetry which is associated with congenital wry-neck. The right side of the face is not so well developed as the left side, and there is also a cross-bite of all the teeth anterior to 6/.

It is not possible to say to what extent the malocclusion and asymmetry are the result of intra-uterine pressure, but it seems reasonable to suppose that it has some bearing on the condition.

It is not only injuries to the condyle which cause malocclusion to develop but even slight changes in the amount or direction of growth of the condyle will cause big changes in the occlusion.

If the rate of growth of the condyle is normal it can still cause malocclusion if the angle is too vertical or too horizontal. In the first case the total vertical height obtained will be too great whilst there will

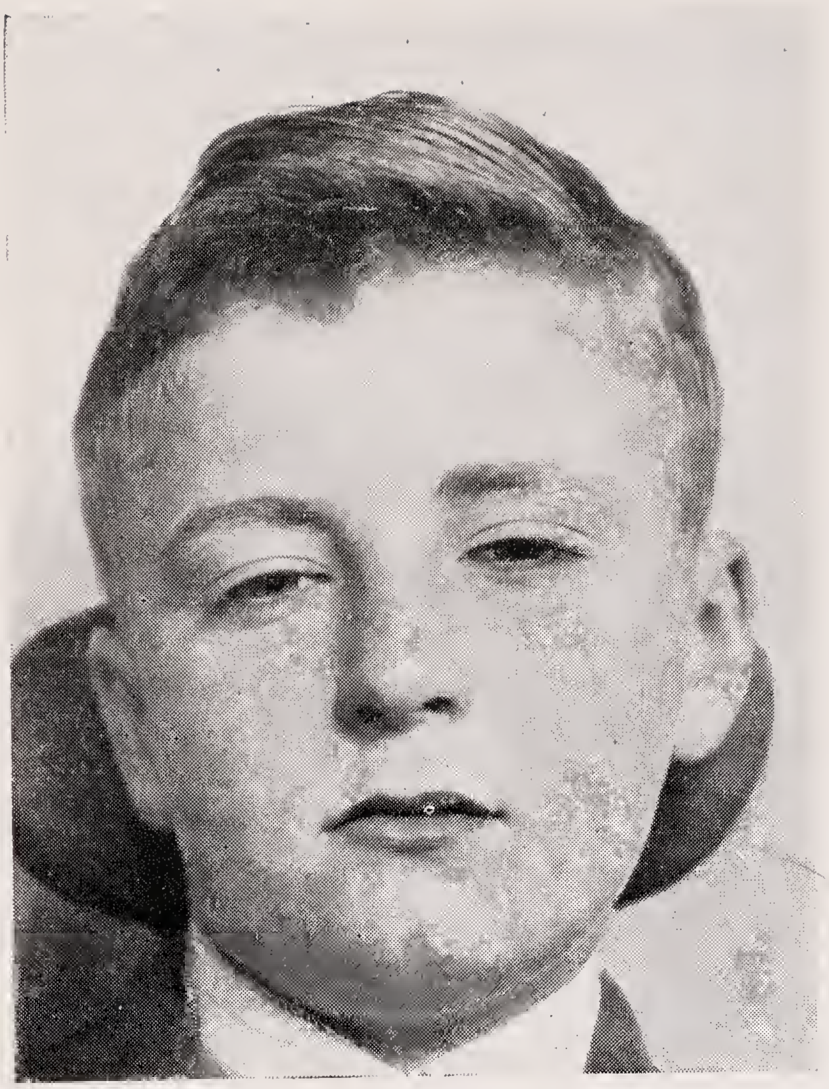


FIGURE 8

be insufficient forward growth, which will have the effect of allowing over-closure of the jaws, because there is too much vertical room in the molar region, and the mandible will be in a post normal position with respect to the maxilla, or in other words we have the very familiar condition which is often referred to as Angle's Class II, Fig. 9a.

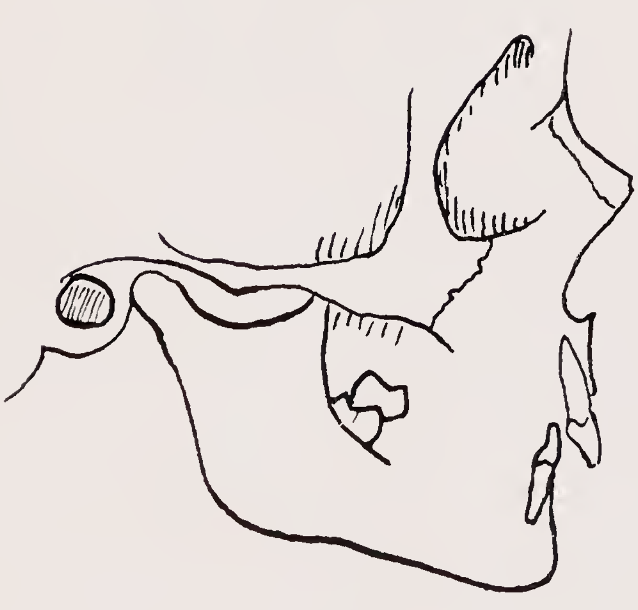


FIGURE 9(a)

If the angle of growth of the condyle is too horizontal there will be insufficient vertical height to allow normal eruption of the molars whilst there will be too much forward growth. This will have the effect of gagging open the mouth on the molars whilst the lower jaw will protrude beyond the upper with open bite of the incisors or a typical Angle's Class III, Fig. 9b.

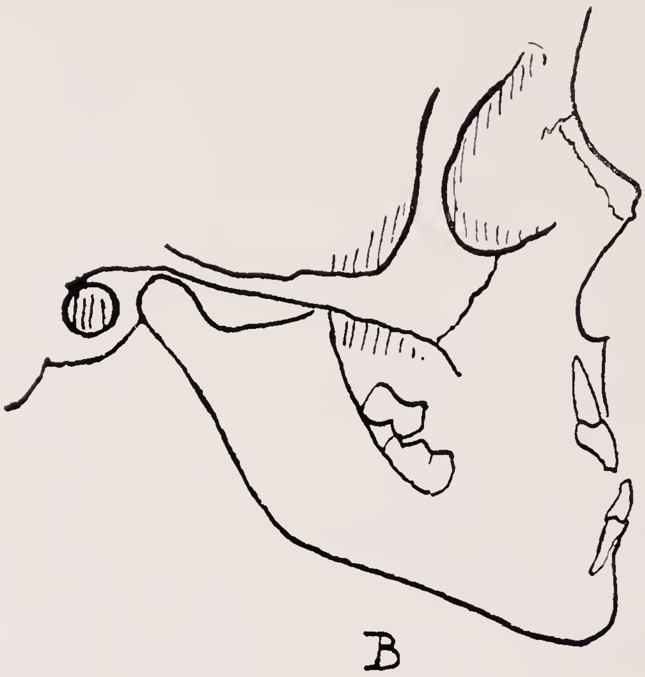


FIGURE 9(b)

When the growth of the condyle is less than that which is required, the effect on the occlusion will vary accordingly to the angle of growth but open bite in the incisor region will be a common feature. These types of cases are always very difficult to treat and it is quite often impossible to produce a satisfactory orthodontic result, Fig. 9c.

FIGURE 9(c)

Where the growth of the condyle is in excess of requirements very varied conditions are created from the severe type of prenormal occlusion illustrated in Fig. 9d,

FIGURE 9(d)

which can only be treated surgically, to a very severe close bite which does not respond to orthodontic treatment.

Finally there is the very important and as yet highly speculative question as to how much the growth of the condyle can be modified by orthodontic treatment or by habits such as thumb-sucking. What happens for example following the successful treatment of a post-normal occlusion? Is a new joint formed anterior to the old one, are the teeth merely dragged through the alveolus to form a new occlusion, or is growth stimulated at the condyle? All three theories have their supporters but the formation of a new joint seems very doubtful. The use of intermaxillary elastics no doubt causes tooth movements in the alveolus to a large degree whilst the use of an Andresen appliance favours both tooth movement and condylar growth.

There seems little doubt that habits such as thumb-sucking do cause post-normal occlusion by modifying condylar growth although most orthodontists have seen an occasional case where persistent thumb-sucking had has no adverse effect.

Whatever the answers to these important questions may be, there is no doubt that further study of condylar growth will eventually supply them.

I am indebted to Dr. R. O. Walker for permission to show cases 2 and 3, and to Dr. E. Davies-Thomas for permission to show case 4. I also wish to thank Mr. E. B. Brain of the dental pathology department of Birmingham University for the histological preparations and photomicrographs.

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Discussion

The President said that the paper had been most interesting. It raised many debatable points.

She was particularly interested in cases of injury to the condyle. There seemed to be a great deal that was not known, not only about growth which did not take place following an injury but also about the growth which did take place, despite the injury. One would expect the appearance to become progressively worse when growth continued on one side if there was no growth on the other side. Strange to say, she had seen cases in which, after a certain number of years, the appearance seemed to improve. She did not know whether there was some compensatory

growth on the injured side, but she would be interested to know whether Mr. Day could give any information on that point.

In two cases—Nos. two and four, she thought—the asymmetry was the width of the lower incisor. In No. 2 this was, at ten years after an injury which took place at twelve months. In No. 4 the injury had only occurred two-and-a-half years previously, and it seemed surprising that the asymmetry should be the same.

There were undoubtedly many speculative questions in the paper, and X-rays would perhaps be of value in giving some proof of what had happened at the condyle and whether the direction of growth of the condyle did produce these various malocclusions, as Mr. Day suggested. The paper was now open for discussion.

Mr. Leighton congratulated Mr. Day on his paper and on the cases he had shown.

He asked whether there was any asymmetry of the upper jaw in the cases where the condylar growth was deficient on one side. He had noticed that in cases 3 and 4 there appeared to be some asymmetry of the middle third of the face. The eye on the affected side seemed to be depressed and the nose to deviate to one side. He might be mistaken and it might be due to the pulling over of the soft tissues by the mandible.

Miss Smyth said she would like to add her congratulations to those already expressed and to put a question supplementary to the one just asked.

In every case, she had asked herself what line one could take as being the normal centre line and what line as being horizontal. The eyes seemed to be completely on the wrong line, but the heads were not apparently all set according to any one position or standard. What centre or horizontal line did Mr. Day take in judging asymmetry ? For orthodontists symmetry was most interesting and important, and one must have a standard by which to judge.

Mr. Tulley thanked Mr. Day for his interesting paper. He said that there was one thing he had noticed in a number of cases: the way in which the alveolar bone attempted to compensate for the malformation. In other words, the lower incisors were brought up by an overgrowth of alveolar bone, making the bone triangular in shape. In one case of Professor Rushton's the mandible had swung over due to a unilateral condylar overgrowth and the alveolus remained in more or less the same position as though the mandible had not been malformed.

Mr. Watts asked at what age Mr. Day recommended that operations for ankylosis of the condyle should take place.

The President called upon Mr. Walpole Day to reply.

Mr. Walpole Day said that he agreed with the President that many of these cases did not appear to get worse later on, as one would expect, but seemed to reach a sort of static phase. He had not followed them up for long enough to know the ultimate result in many cases, but they were extremely interesting. Some of them did develop this asymmetry quite early and soon after the injury, but it did not seem to get much worse afterwards.

He agreed that X-rays would be a great help, but at the time when he had been collecting these cases—which was some four years ago—he had not got facilities for taking reliable lateral X-rays. He had not at that time got a craniostat in which he could line them up so the lateral X-rays would have been of practical use.

With regard to the case of the child who had had an injury when about a year old and the other case of the child who was twelve, it had been suggested that there was the same amount of drift of the centre line i.e. the width of one lower incisor tooth. That was quite true, but he did not know the reason. It might be that the younger case had become static after a time. The older child had lost the first four permanent molar teeth. He did not know whether that would have any bearing.

Mr. Leighton had asked about the asymmetry of the upper jaw. In the case of the older child who had developed asymmetry after a tonsil operation, there was very great asymmetry in the upper jaw as well. In all these cases there was a lot of asymmetry in the upper jaw, which really answered Mr. Tulley's question about the alveolar bone compensating. He felt sure that the alveolus did compensate to a very large extent in trying to bring about some sort of occlusion in these rather tragic cases.

In the first case, where the condyles were broken at birth, there was remarkably good occlusion. It was rather surprising, and he was not quite sure where the growth had come from to enable the lower incisors almost to meet the upper ones. But the line of occlusion was all wrong, and the lower incisors sloped forward, almost horizontally.

Miss Smyth had asked about the centre line and how asymmetry was judged. The difficulty with full face photographs was one took them with the patient as nearly as possible upright and when they came to be printed on a lantern slide, the result was not exactly what one had intended. In taking prints, he had trimmed them most carefully to get the head exactly where he considered it was upright. He agreed, however, that it was extremely difficult to judge of the symmetry of these cases.

As a rule the two sides were not exactly equal, even in the most normal people.

Mr. Watts had asked about the date of the operation. With operations on bones where there was a symmetry or something of that kind, for example, if one bone in the fore-arm stopped growing and not the other, the usual course was to judge the date of the operation according to the damage that was being caused. In the case of the mandible if there was severe ankylosis or less than enough space to admit a thin biscuit, one had to operate fairly early to make it possible for the child to feed itself. If, on the other hand, one was operating from an aesthetic point of view, provided the patient could eat, the best time to operate would probably be soon after the bones had stopped growing.

A Treated Case of Transposed Upper Canine

H. SCHACHTER, F.D.S.R.C.S. (Eng.)

Transposition of a tooth, either partial or complete, is a comparatively rare anomaly. It may be considered a symptom, a result of some disturbance early in the developmental period of the teeth. It is often accompanied by other anomalies in the same patient, such as absence or malformation of other teeth, or supernumerary or supplemental teeth. This seems to emphasize the importance of hereditary factors in the etiology.

The treatment, if any is indicated, is usually dictated by expediency. The position of the crown, the inclination of the root, and the general condition of the dental arch guides the orthodontist.

The tooth most frequently affected is the upper canine. It has a long course to travel from its point of origin into full occlusion, and its displacement is not infrequent. I found 25 cases of transposition reported in the dental literature, four-fifths of which concern this tooth. About half of them show the canine erupting between the upper central and lateral incisors, and half between the premolars. Transposition of incisors and lower canines is rather rare. Symmetrical transposition is reported several times. I myself have seen three cases, all of them upper canines. In one the right upper canine erupted between the premolars, the first premolar being rotated 90° so that the buccal surface pointed mesially. The second case had a family-history of displaced upper canines in three successive generations. The position of the tooth was so unfavourable in this case that I had to remove it to avoid the danger of root resorption of the incisors. The third case is the one I am presenting now.

When I first saw this patient, a boy, he was 9 years 3 months old. There was nothing unusual in his history, but his mother had both upper lateral incisors congenitally missing. Clinical examination showed normal occlusion of fairly well

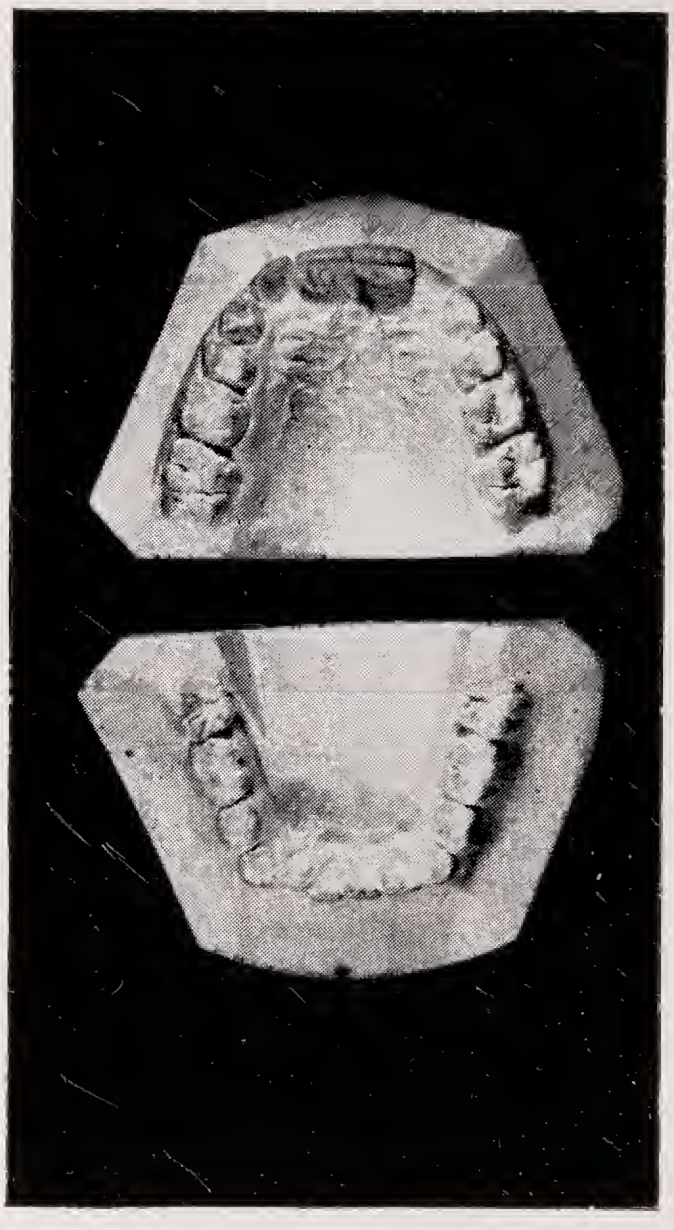

FIGURE 1.

Short Communication presented to the meeting 12th March.

developed arches, but the left upper lateral incisor had failed to erupt (Fig. 1). X-ray examination revealed an inverted unerupted supernumerary tooth with enlarged pericoronal space lying in the palate behind the left incisors (Fig. 2). It is interesting to note the normal position of the left canine crown and lateral incisor root at this time.

The supernumerary was removed under local anaesthesia and the lateral erupted some months later. Two years later (age 11yrs. 6 months) the crown of this

FIGURE 2.

tooth seemed to rotate gradually round a horizontal axis, and the deciduous canine, already shed on the right, was still firm. No prominence could be felt on the palate or in the labial sulcus. X-ray showed the permanent canine pushing its way between the roots of the incisors. To localise the crown, two pictures were taken and the central-ray directed more distally in the second one (Fig. 3-a and 3-b). This showed the canine moving apparently mesially, thus indicating its labial position to the lateral incisor root.

It was thought advisable to expose the canine crown surgically. Under local anaesthesia the labial surface and the incisal tip was uncovered. It was found on the labial side but fairly deep and about level with the central incisor root (Fig. 5a, b). It might have appeared expedient to tilt the lateral incisor distally into the space of the deciduous canine, which had to be extracted, and let the canine erupt between the incisors, in that way transforming a partial transposition into a complete one. Such treatment was in fact reported in some cases in the literature. Considering the root inclination of the canine, I thought an attempt should be made to bring the teeth into their proper place, in spite of the perhaps unfavourable prognosis.

The crown of the canine was first moved labially by zinc-oxide gauge packs pushed under the palatal aspect, changed every 10 days for about 2 months. It was then possible to put on a cast band with a hook, and the patient wore elastics at night only to another hook in the second premolar region of a removable appliance. The deciduous canine was extracted, and the permanent one moved across the root of the lateral incisor disto-occlusally into its place. This part of the treatment took about one year. Now the root of the lateral had to be uprighted. Five months' treatment with a removable appliance produced no result, so a fixed appliance was cemented which completed the neces-

FIGURE 3. (a)

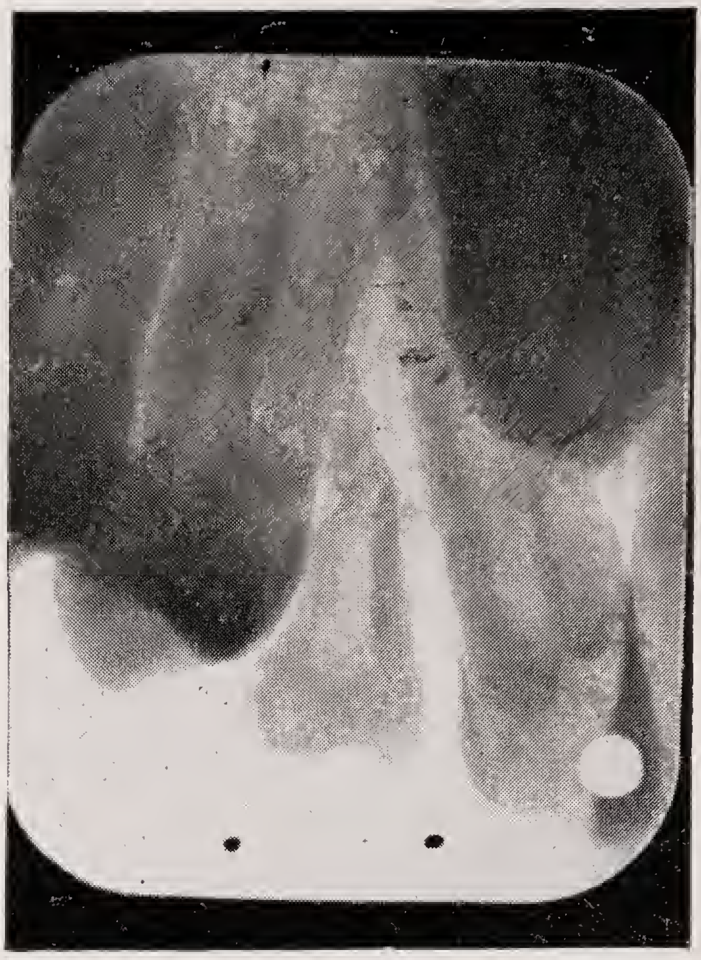

FIGURE 3. (b)

FIGURE 4 (a)

FIGURE 4. (b)

FIGURE 5. (a)

FIGURE 5. (b)

sary movement in the short time of seven months without causing any soreness. Finally the patient wore a removable appliance at night only to align the canine and the lateral incisor. Fig. 4a shows an X-ray film before, and 4b. after the root movement of the lateral. Final models were taken three years after, the exposure of the canine crown (Fig. 6a, b). One detail worth mentioning is that the crown of the lateral in its position before treatment took up more space than was needed for it after uprighting and alignment, and so provided the additional space for the permanent canine after extraction of its predecessor.

Apparently, no damage was caused to the pulp of the canine and lateral, which responded normally to thermal and electrical tests one year after active treatment was completed. Fig 4b. shows no root resorption, but the alveolar margin is higher on the lateral. The labial gum margin is higher on the left, treated, canine than on the normal right one (Fig. 5a), but there are no gum pockets on either of the moved teeth.

I think this case which was under observation for over seven years might be of interest because it may shed some light on the etiology of some types of transposition.

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FIGURE 6. (a)

FIGURE 6. (b)

Discussion

The President congratulated Mr. Schachter on his very good result in what she would consider a very difficult case. He was fortunate, she said, that there was no resorption of the root of the lateral incisor. That was what she was always nervous of in these cases; but the X-ray showed that no damage had been done. The communication was now open for discussion.

Mr. Watkin said the speaker had mentioned the case where the canine was left in position between the two premolars. He had had a case of that kind, and the appearance was not at all satisfactory. The gingival margin of the canine was much higher than that ofthe premolars, and when the patient smiled, the result was not pleasing. In view of this, he had taken the 1st premolar out and had pushed the canine forward with very satisfactory results.

Mr. B. Maxwell Stephens observed that the success of this case had undoubtedly been contributed to by the long period over which the treatment was given. It would probably aid the tissues to rehabilitate and retain the teeth in place. A long period was of the greatest importance.

Mr. Walpole Day congratulated Mr. Schachter on his excellent result. He himself, he said, had tried, sometimes successfully and sometimes otherwise, to rehabilitate unerupted canine teeth, and he had shown some at the Society many years ago. In the report that was eventually reprinted in an American journal, the comment of the Editor who was Salzman—was that American orthodontists did not consider it necessary to drill holes in teeth. This was in 1944 or 1945. After that, thinking there was perhaps something in it, he had done about fifty cases without drilling holes. He had had a very similar case, however, which he was still treating and which he had been treating for two years, and he had tried for eighteen months to avoid drilling a hole. He had been unable to separate it from the lateral. One could not get a band on to it, even under an injection. Eventually, he had reluctantly had to drill a hole. Mr. Schachter's tooth was tilted with the lateral side towards the central teeth. In his own case, the tooth was tilted the other way and he was unable to get round the other side of the crown; but he was making progress.

In treating an upper canine, he had found that provided the apex was either too far back or approximately in the position in which one wanted it to be, one was all right. But if one wanted to correct a canine tooth which had travelled too far forward, one could not push the apex back without devitalising the tooth. The important point was that in Mr. Schachter's case he was fortunate in that the apex, which might have been far forward was not too far down. He did not have to shorten the canine tooth to push it back. Many people had ended with a dead tooth, and he thought the answer was that one could not push the canine back into the socket at all.

Mr. Lindo Levien noted that to move the tooth it took two months with zinc oxide and said he had found that if one got as much bone away as one could, one could get the cap on in about a week—a gold cap with a hook soldered to it.

The President called upon Mr. Schachter to reply.

Mr. Schachter said in reply to Mr. Watkin that the patient did not want any treatment and that was why none was done. He did not consider the appearance satisfactory himself.

In reply to Mr. Lindo Levien he said that he did not want to apply too much force—certainly not gutta-percha—because the tooth had a comparatively short root and was in any case rather loose and he did not want to make it looser at this stage. He had therefore taken a little longer to put a band on it.

In reply to Mr. Walpole Day he said that he certainly considered it favourable that the apex of the canine was distal, but he had thought some damage might be done to the lateral, the apex of which had to be moved quite a distance forward.

Tubular Lingual Arches

By J. S. Beresford, B.D.S. (N.Z.), H.D.D. (Ed.)

There are three methods generally practised of attaching auxiliary springs to stainless steel lingual arches. The spring may be wrapped across a bend or loop in the arch wire, a sleeve of .05 mm. tape may be welded to the arch, or the spring may be welded directly to the arch and given two or three turns about it. *Figs.* 1 and 2. In comparison with the precious metal technique, where the end of the spring wire is simply soldered to the arch wire, these attachments are all bulky and the third method has the added disadvantage of being not wholly reliable.

In an effort to find a more satisfactory attachment the tubular lingual arch of Johnson has been adopted with modifications. The appliance has been well described by Madden and is clearly illustrated in his publications. The object of the modifications was a removable type of lingual arch with the springs attached anterior to the posts or locks.

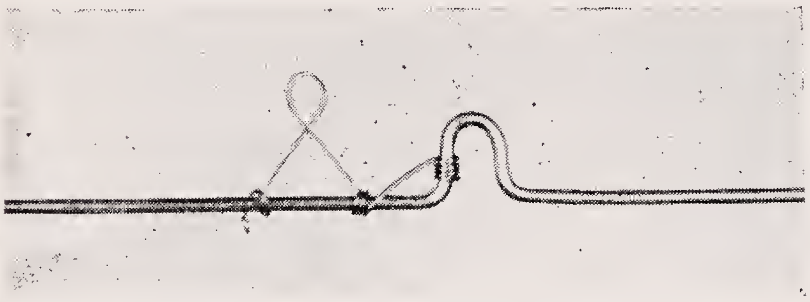

FIGURE 1

Auxiliary spring attached by wrapping about a bend.

The writer's imperfect technique is presented in the hope that other members of the profession will be able to effect improvements in it.

TECHNIQUE OF BENDING THE TUBULAR ARCH

The stainless steel tubing has the same dimensions as that used for the " end tubes " of twin wire arches; i.e., outer diameter 0.036in. x inner diameter 0.020in. (approx. 0.9 mm. x 0.5 mm.). This steel tubing is very hard and brittle and must be annealed to a degree that renders it amenable to bending without destroying all its properties of " springiness." It is heated just to a dull red, quenched, and polished. A convenient length is taken and a thread of nylon surgical ligature, stout purple N.7 or extra stout green N.8, is inserted from each end, the two pieces of ligature meeting in the centre of the

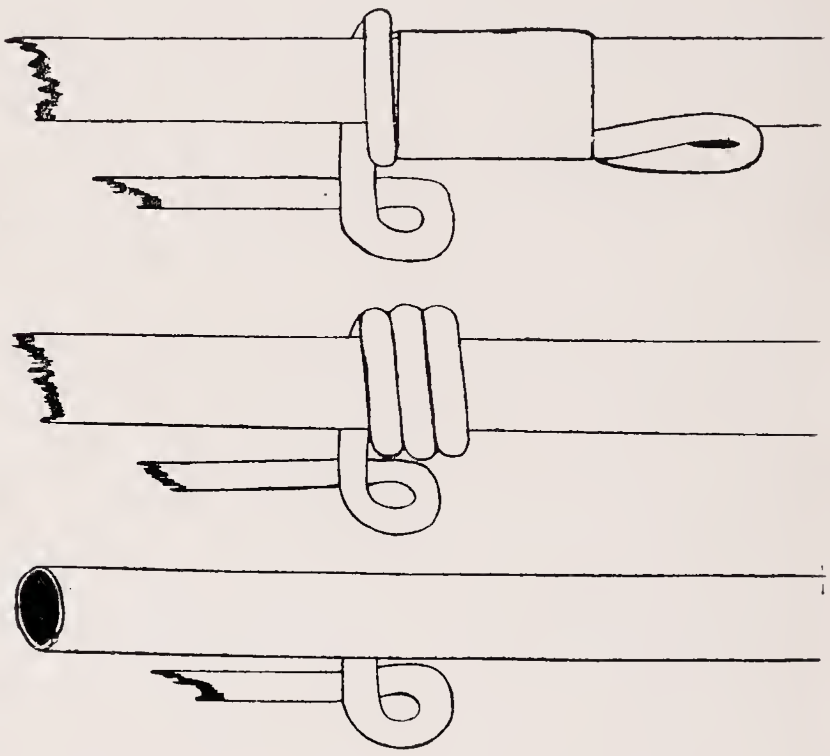

FIGURE 2

Auxiliary spring attachments to a straight section of arch wire: (above) by means of tape; (centre) by welding and coiling; (below) by insertion into a tubular arch.

Demonstration at the meeting held on 7th May.

tubing. Their object is to support the tubing, guarding against the tendency common to all tubes to flatten when being bent. There is a limit to the number of curves and bends through which the nylon ligature may be withdrawn. That is why two pieces which are withdrawn from opposite ends are used. Most lingual arches have a bend of 60° to 90° in the canine region. When this bend has

FIGURE 3

Left, spring wire shaped for insertion. Right, sectional diagram of spring inserted into tubular arch.

been made the nylon should be withdrawn about ¾in. from the tube so as just to clear that bend. If the arch is to be of a complicated pattern a further withdrawal will be indicated after two or three more bends. A simple lingual arch with a loop or bend anterior to the lock does not require more than the one partial withdrawal of the nylon thread. Conventional wire bending pliers with one round and one flattish beak are suitable for bending the tubing. It is a considerable advantage to have a transverse groove cut in the beaks well away from the tips. The green N.8 nylon is stouter and affords a better support than the purple N.7, but the latter may be withdrawn around a greater number of " corners."

The nylon is withdrawn from the completed passive arch. Half an inch of soft wire, e.g., brass separating wire or 0.5 mm. soft stainless steel, is inserted to reinforce the arch at each of the ends which are then bent around to form the locks.

TECHNIQUE OF ATTACHING SPRINGS

At the point where the spring is to be attached a small slot is cut in the side of the tubular lingual arch with a No. 1 wheel bur. The shaft of the bur is held at right angles to the arch. The length of the slot is made a little greater than the diameter of the bur. Stainless steel wire 0.35 mm. in diameter is used for the spring and is shaped as shown in *Fig.* 3 before being inserted in the tubular arch. The semi-circular portion slides in readily, but some degree of force, carefully controlled, is required to spring the double bend into the tube.

These springs are very firmly held, but an additional precaution is recommended in the case of free ended springs (i.e., springs designed without the slide or runner usual in the case of light steel springs). Two

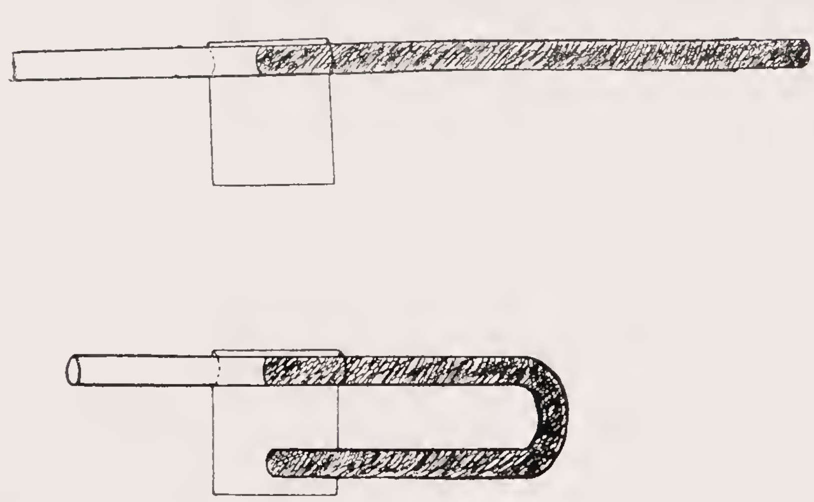

FIGURE 4

The distal extremity of the arch is reinforced with an inset of soft wire (0.5 mm. diameter) and shaped for the lock. In this case a McKeag post is used.

slots, half-an-inch apart, are cut in the tubing. The spring is inserted in the first slot and reappears at the second slot where it is held with 14 ct. solder.

SUMMARY

The construction of a modified tubular lingual arch, based upon that of Johnson, and a method of attaching springs to it have been described.

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The Orthodontic Treatment of Cleft Palate using the Harvold Principles

M. A. KETTLE, L.D.S., R.C.S.

THE TYPICAL COLLAPSE of the upper arch in complete cleft palate cases together with the usual pre-normal relationship of the jaws, has long been a serious orthodontic problem.

The form of the dental arch is intimately related to the pressures exerted by the tongue, cheek and lips. The ultimate position of the teeth may be considered to be an expression of these forces.

A child born with cleft palate and hare lip has lost the lip pressure and, as a result, the pre-maxilla is thrust forwards and upwards.

Early surgical treatment aims at the closure of the hare lip and front of the hard palate. The restored tension of the repaired lip muscles retracts the pre-maxilla into position. During the first 1—2 years, the position is relatively normal, especially where the overlapping of the temporary incisors is sufficient. A mesial drift of the maxillary segments occurs which closes the cleft anteriorly. This movement is more marked on the side of the cleft which is not attached to the nasal septum. The operation on the hard and soft palate between 2—4 years appears to hasten the movement, when it has not already taken place. The segments of the upper arch are moved together in front, by pressure from the lips and cheek until the alveolar processes are in contact. The dental arch is reduced in proportion to the width of the cleft. The lingual displacement of the pre-maxilla and the medial displacement of the maxillary segments close the cleft space in front.

Every reduction of the alveolar process in the region of the cleft, due to loss of teeth or malposition in the permanent dentition, leads to a further compression of the two halves of the alveolar process. This movement appears to be a forward and mesial rotation of the maxillary segments. The upper lip in the early years of life, controls the position of the pre-maxilla in a favourable way, but a tight lip later checks the forward growth of the upper jaw.

During this time the downward and forward growth of the lower jaw, may proceed independently of the upper arch. A pre-normal condition may result from a progressive deterioration in the antero-posterior relationship of the two arches.

The treatment consists of an expanding movement of the maxillary segments retracing the medial drift which has occurred. By this means an attempt is made to restore the segments to the position they would have occupied had there been no cleft.

A Demonstration at the meeting held on 7th May.

The case of complete unilateral cleft palate shown was treated by means of .6 m.m., S.S.W. spring attached to bands on 63 | 46. An attachment (*Fig.* 1) fitted into vertical tubes on the palatal side of 6 | 6 and the free arm attached to hooks, soldered palately on 3 | 4 bands (*Fig.* 2). Tension was placed in the W spring, which produced a lateral and distal movement (*Figs.* 3, 4 *and* 5) show before and after results (*Fig.* 6) shows temporary appliance in position to rotate 1.

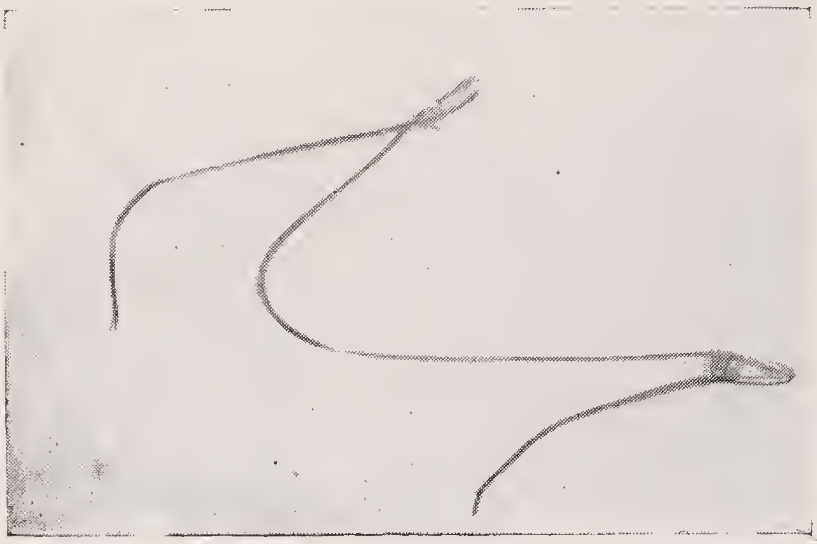

FIGURE 1

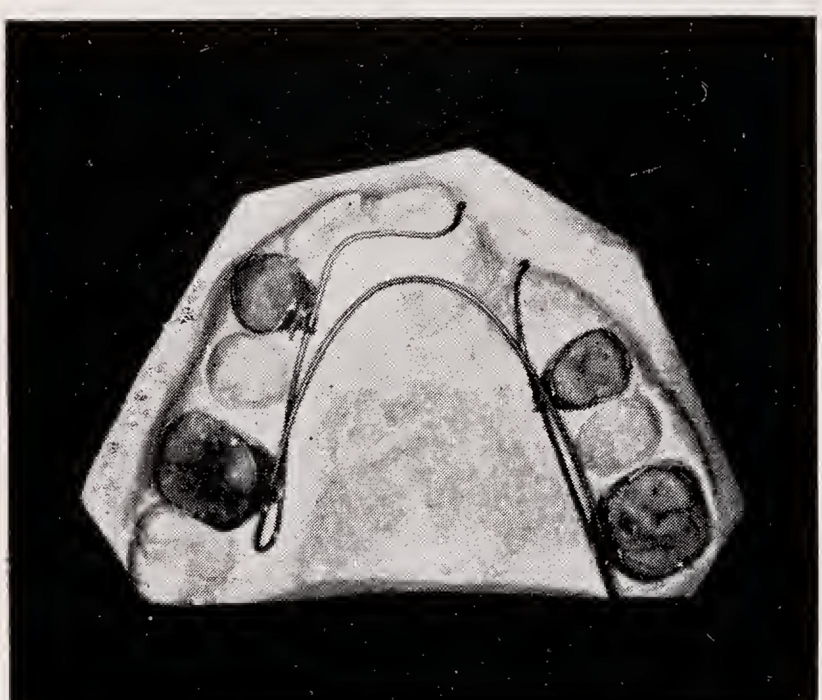

FIGURE 2

FIGURE 3

FIGURE 4

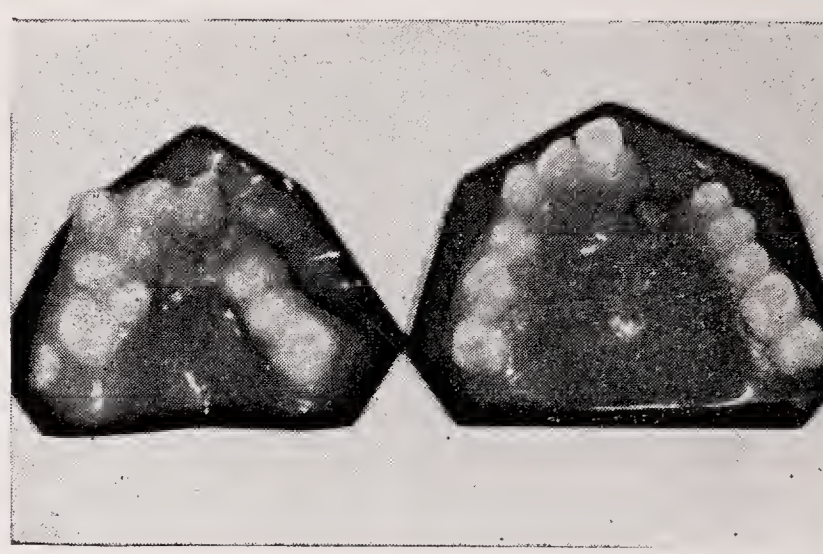

FIGURE 5

FIGURE 6

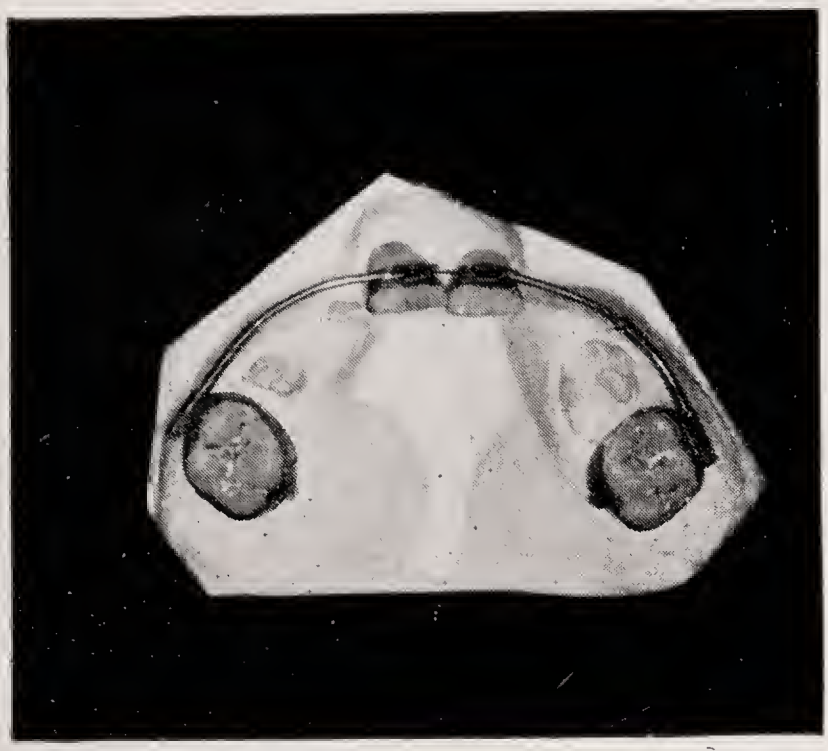

FIGURE 7

FIGURE 8

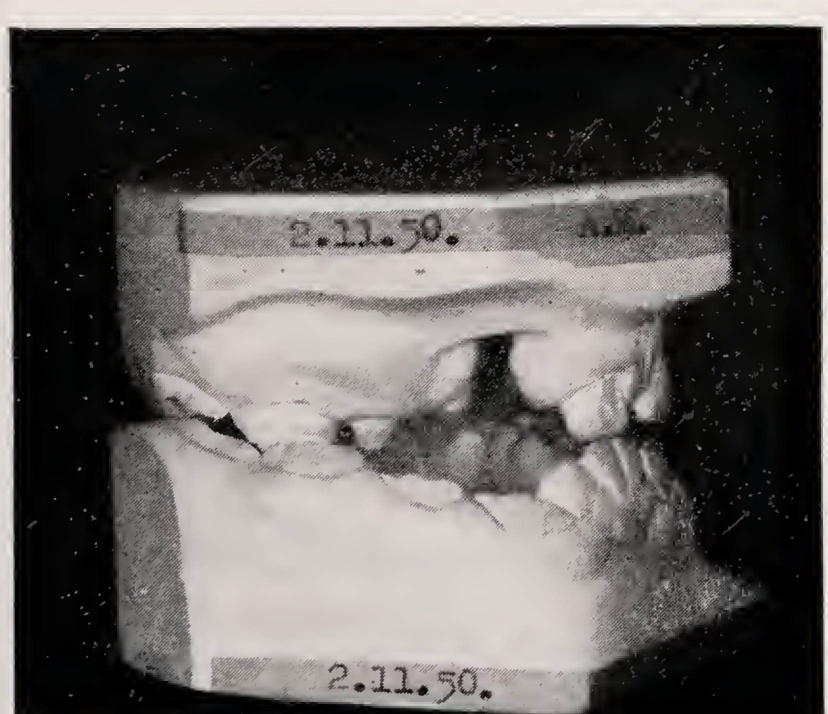

FIGURE 9

FIGURE 10

FIGURE 11

The case of bi-lateral complete cleft palate shown, was treated by the use of a Johnson Twin Arch apparatus, which moved the pre-maxillary segment forwards (*Fig*. 7). Coil springs acting on the buccal tubes moved the free segments into better relationship with the lower teeth and helped to retain the upper lip in a more favourable position. In this case an Abbè operation was first performed by Mr. Nils Eckhoff, to loosen the upper lip (*Figs*. 8, 9, 10, 11). The segments are later retained by removable appliances, until the child is old enough to have permanent bridge fixation of the segments.

My thanks are due to the Dental Council, Guy's Hospital, for providing facilities for the illustrations; to Mr. K. E. Pringle, Assistant Dental Surgeon to the Children's Department, Guy's Hospital, for his great help and encouragement; to Mrs. Small, Photographer, Guy's Hospital, for photographs.

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The Applied Anatomy of Orthodontics

W. J. Tulley, B.D.S., F.S.D., R.C.S.

The aim of the demonstration was to correlate some aspects of the developmental and topographical anatomy of the head and neck which are of interest to the orthodontist.

The general growth trends of the facial skeleton in relation to the skull as a whole were shown by using a modified Broadbent diagram, and the sites of growth of the cranial base illustrated on the skull of a full term infant.

Lateral radiographs showing the soft tissues of the oral cavity in infancy and young adult life, were used to illustrate the change in relationship between lips, tongue, soft palate, and laryngeal skeleton.

The oral cavity in infancy is bounded by muscular walls. The lips form the anterior boundary, particularly the lower lip (Fig. 1). The gum pads are widely separated at birth and the tongue is in contact with the lips in the position of rest and largely fills the space between the jaws. As the teeth erupt and the alveolar processes develop, the space between the jaws fills up, and the teeth come to be only separated by a few millimetres at rest.

In the act of swallowing, the soft tissue boundaries of the oral cavity should gradually be replaced by a rigid walled boundary formed by the teeth and alveolus. (Rix 1946).

As the facial skeleton grows the laryngeal skeleton descends in the neck. There is no longer any relationship between the soft palate and epiglottis which is necessary during the suckling phase of infancy.

Diagrams were used to illustrate the topographical anatomy of the muscles surrounding the dental arches. The important muscles of the groups forming the anterior oral sphincter were emphasized and the continuity of the buccinator fibres with those of the superior constrictor over the pterygo-mandibular raphé. (Brodie 1950). (Fig. 2/3). Thus a complete band of muscles surrounds the dental arches and pharynx, and it is tied back to the base of the skull posterior to the main site of growth.

FIGURE 1.
Lateral radiograph showing soft tissue boundaries of the oral cavity in infancy.

Demonstration presented to the meeting on 7th May.

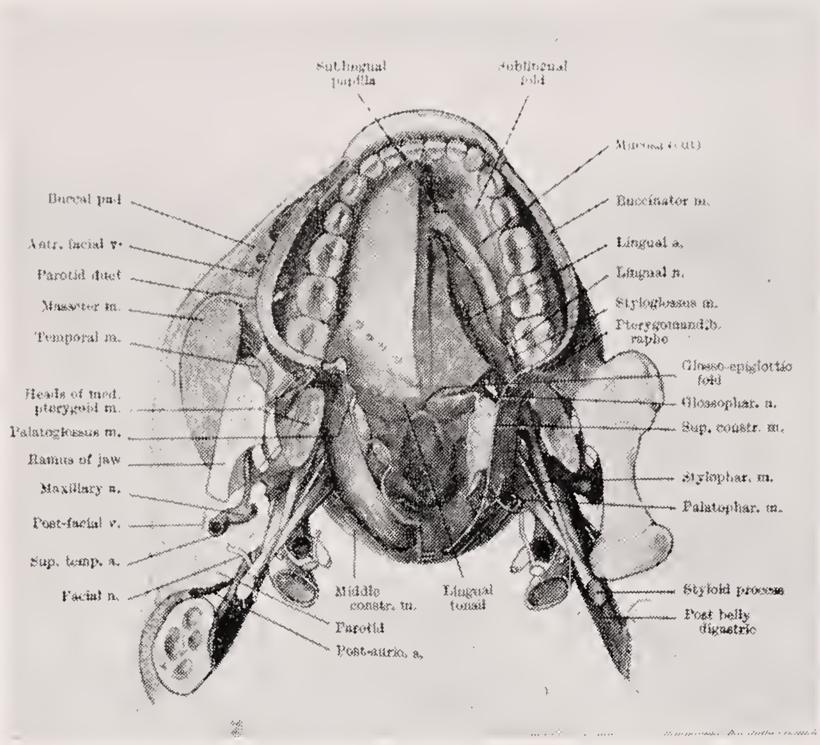

FIGURE 2.

Drawing of dissection to show muscles surrounding the dental arches. (*From Anatomy for Dental Students. Lucas, Keen, and Whillis. By permission of Edward Arnold Co.*)

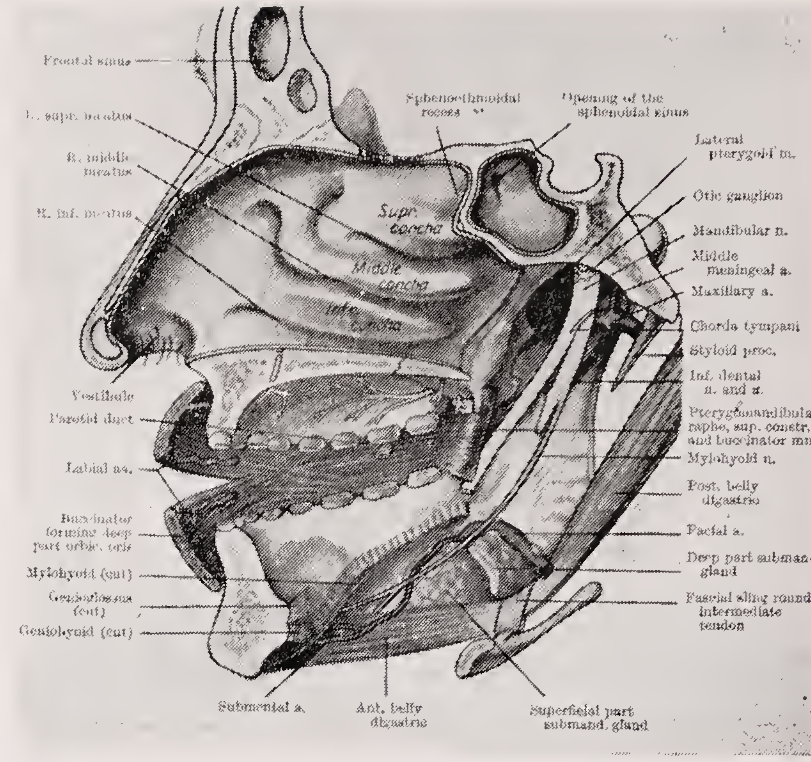

FIGURE 3.

Drawing of dissection to show muscles surrounding the dental arches. (*From Anatomy for Dental Students. Lucas, Keen and Whillis. By permission of Edward Arnold Co.*)

Brodie has pointed out this sheath of muscles and the way in which they must be partly responsible for positioning the teeth on the bony base, opposing the movements of the tongue acting in such a diversity of ways on the lingual and palatal aspects.

It was stressed that the developmental and functional changes of the orofacial muscles must be studied in conjunction with changes in the skeletal structures and the occlusion, in order that the developing dental arches may be seen in their true perspective.

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Three Treated Cases

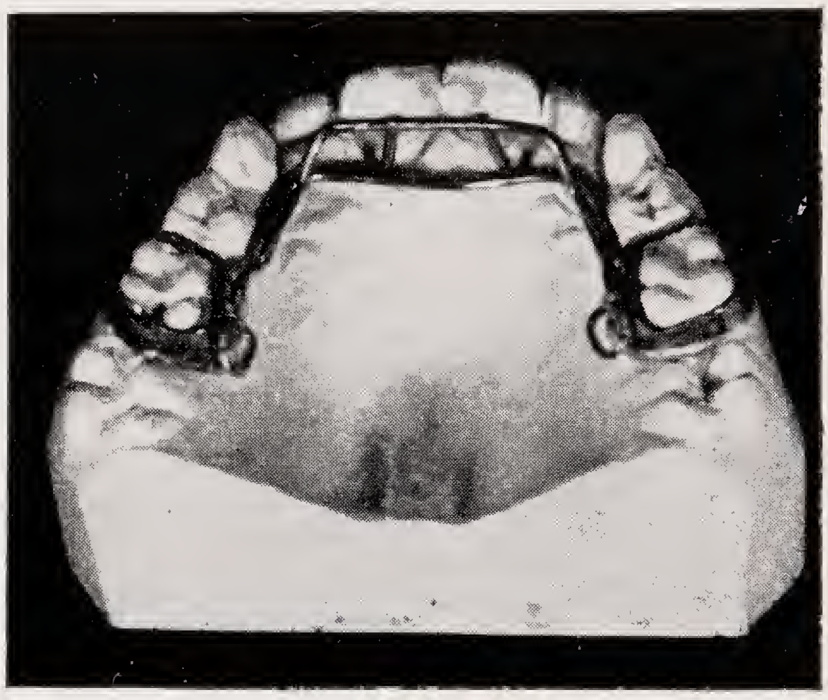
Phyllis A. Watkin, L.D.S., V.U., Manc.

Case I. Age 6 3/12 years
Class I. Open Bite. (Angle)

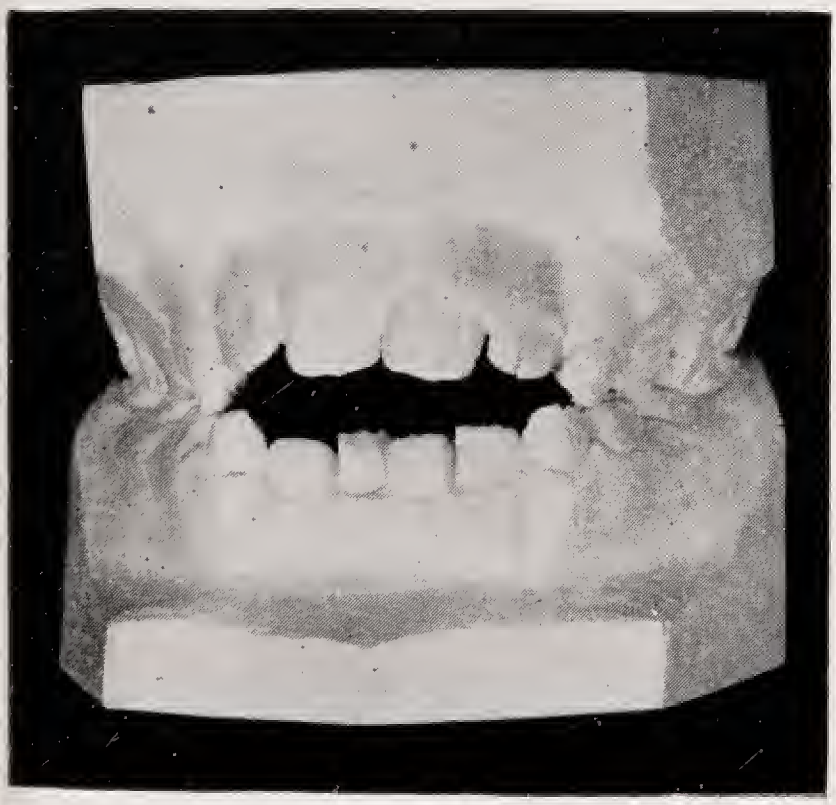
This case was treated with an upper lingual bow carrying a tongue shield, which prevented the tongue from being thrust forward during swallowing and allowed the teeth to erupt farther. It also discouraged the patient's habit of thumb-sucking. The shield was made to fit just behind the lower anteriors, when the posterior teeth were in occlusion. It was worn for six months.

A swallowing exercise also was given, as follows:—

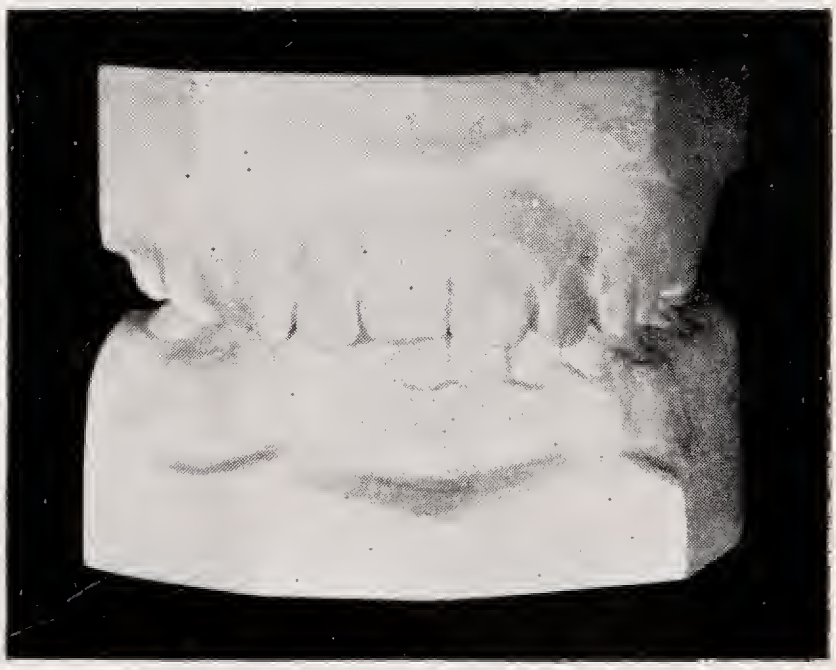
1 Take a small sip of water, enough to moisten the mouth.
2 Watch the mouth carefully in a mirror.
3 Place the teeth gently together and keep them in this position throughout the exercise.
4 Close the lips gently together and swallow with three things in mind.



CASE 1(b)



CASE 1(a)



CASE 1(c)

Presented to the meeting on 7th May.

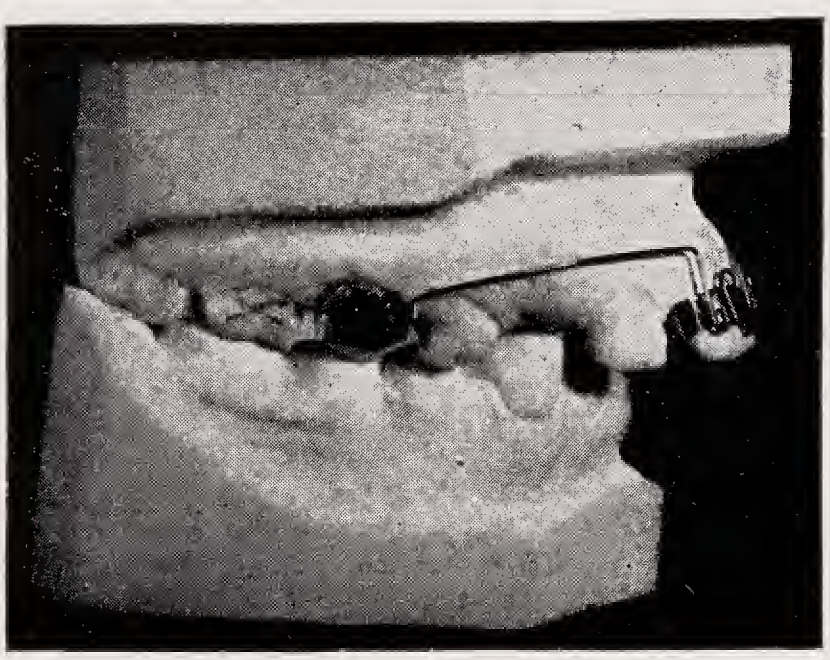
a. To keep the teeth together.
b. To keep the lips perfectly still.
c. To keep the tongue in the roof of the mouth and not pressing against the front teeth.

5 Repeat the swallowing taking small sips of water whenever it becomes hard to perform the act.

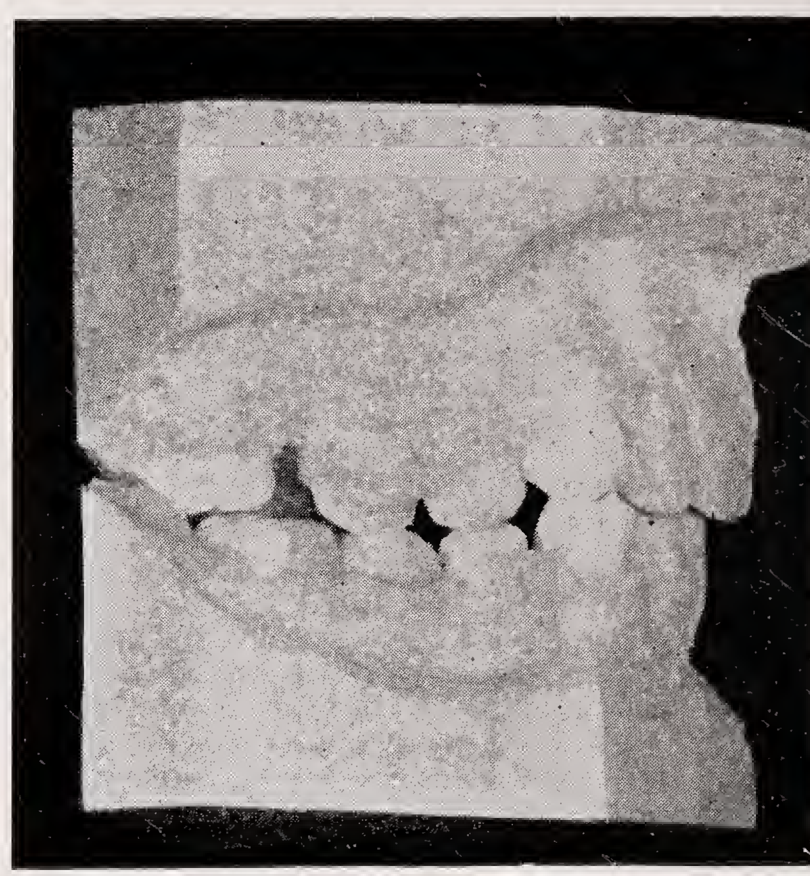
6 Do this for two minutes and for at least three sessions a day. Do it frequently between practice periods and increase the length of the sessions after one week, to three minutes.

Case II. Age 12 5/12 years.
Class II (div. 1.) (Angle.)

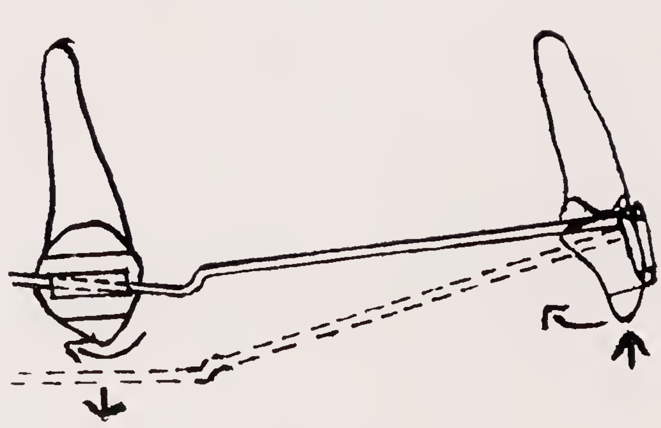
This case was treated by the extraction of 6 | 6, and Pin and Tube appliances first on 51 | 15, then on 52 | 25. Intermaxillary traction was not used. The 5 | 5 were tilted distally by making the ends of the pin and tube wire at an angle to the horizontal tubes on the premolars and not parallel with them—*i.e.* the distal ends were bent slightly upwards, as shown in the diagram.



CASE 2(a)

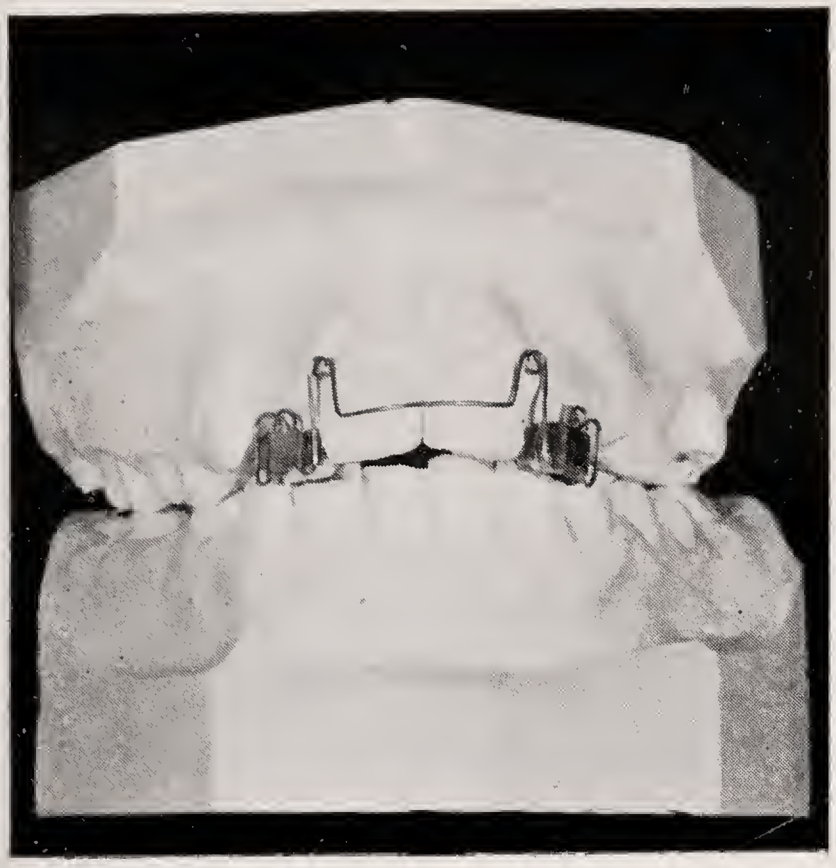


CASE 2(b)



CASE 2(c)

Diagram to show action of Pin and Tube appliance



CASE 3(a)

CASE 3(b)

Case III. Age 11 years
Class II (div. 1.) Open Bite. (Angle)

A local pin and tube appliance was first fitted on 2 | 2 for expansion. 6 | 6 were extracted. An upper lingual bow with a tongue shield was fitted. When sufficient space had been obtained between 2 | 2 to allow for the retraction of 1 | 1, a pin and tube appliance was fitted on 71 | 71.

Appliances in the Treatment of the Collapsed Lower Arch

H. Lester Leech, BDS, LDS.

The collapsed lower arch is the result of several causes, perhaps the chief of which is the early loss of the deciduous molar and canine teeth.

In these cases, the clinical picture of the lower arch is familiar:—

- Premature absence of the deciduous molars;
- Forward tilt of the first permanent molars;
- Retroclination and sometimes imbrication of the permanent lower incisors giving rise to an increased incisal overbite and sometimes increased overjet; i.e. a close bite;
- Lack of space for the permanent premolars and canines.

Associated with these imperfections of the lower arch is often found the resultant collapse of the upper arch, with a lessening of the inter-canine width and imbrication of the incisors.

When there is early loss of the deciduous buccal teeth, the inter-proximal contacts of the teeth are lost, and the anterior component force does not play its part in maintaining the position of the labial segment.

The results are more severe if there is present a fault habit such as thumb-sucking, or an atypical swallow. In the atypical swallow, the tongue is thrust forward between the upper and lower incisors to meet the contracted lower lip, this latter further increasing the retroclination of the lower incisors and the former increasing the proclination of the upper incisors, i.e., a typical Angle Class II Division 1 malocclusion.

In other cases, the muscle action is such as to cause a retroclination of the upper as well as the lower incisors, i.e., an Angle Class II Division 2 malocclusion.

In both these cases, the correct occlusal contact between upper and lower incisors is lost, and the lower labial segment may continue to develop vertically until the incisal edges of the teeth impinge on the soft tissue of the palate; perhaps causing a traumatic gingivitis.

Fig. 1 shows a typical Angle Class II Division 2 type of malocclusion, with collapse of the lower arch and insufficient room for the premolars. There is a retroclination and increased vertical development of the lower incisors with the associated increased incisal overbite.

Treatment

In some cases of collapsed lower arch, the loss of space may be so great that it would be impossible to recreate room for the premolars without proclinating the lower incisors beyond the limits of equilibrium in muscle balance, and the case would relapse as soon as the appliances were removed. In these cases, extraction of a premolar on each side may be the only satisfactory form of treatment.

In the majority of cases it is possible to upright the tilted first permanent molars and proclinate the incisors in order to accommodate the premolars. In so doing, normal contact of the upper and lower incisors is restored and the overbite and overjet reduced to normal proportions.

Fig. 2 shows the result of treating the collapsed lower arch in fig. 1 by antero-

posterior expansion with a fixed lingual arch. Treatment of the upper arch consisted of removal of **4**/**4** and retraction of **3**/**3** is still in progress. Note the reduced incisal overbite and the space restored for the erupting lower premolars.

The cephalometric appraisal in fig. 3 shows the improved incisal relationship which, though far from perfect, is probably the best obtainable on this difficult skeletal pattern without prolonged fixed appliance treatment.

In some cases, if the lower third permanent molars are present, it is advisable to make room for the uprighting of the permanent molars by the extraction of the third permanent molars, or less often the

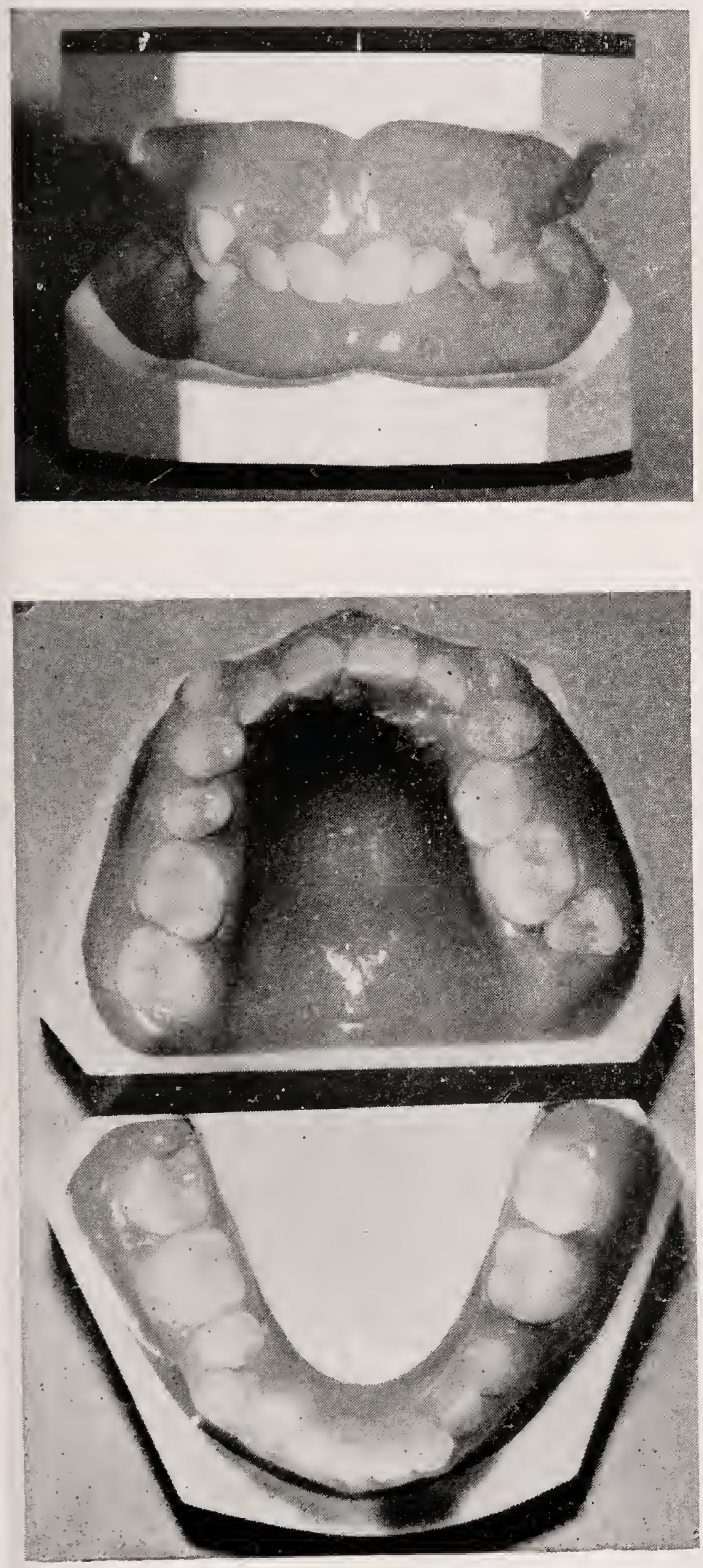


FIGURE 1

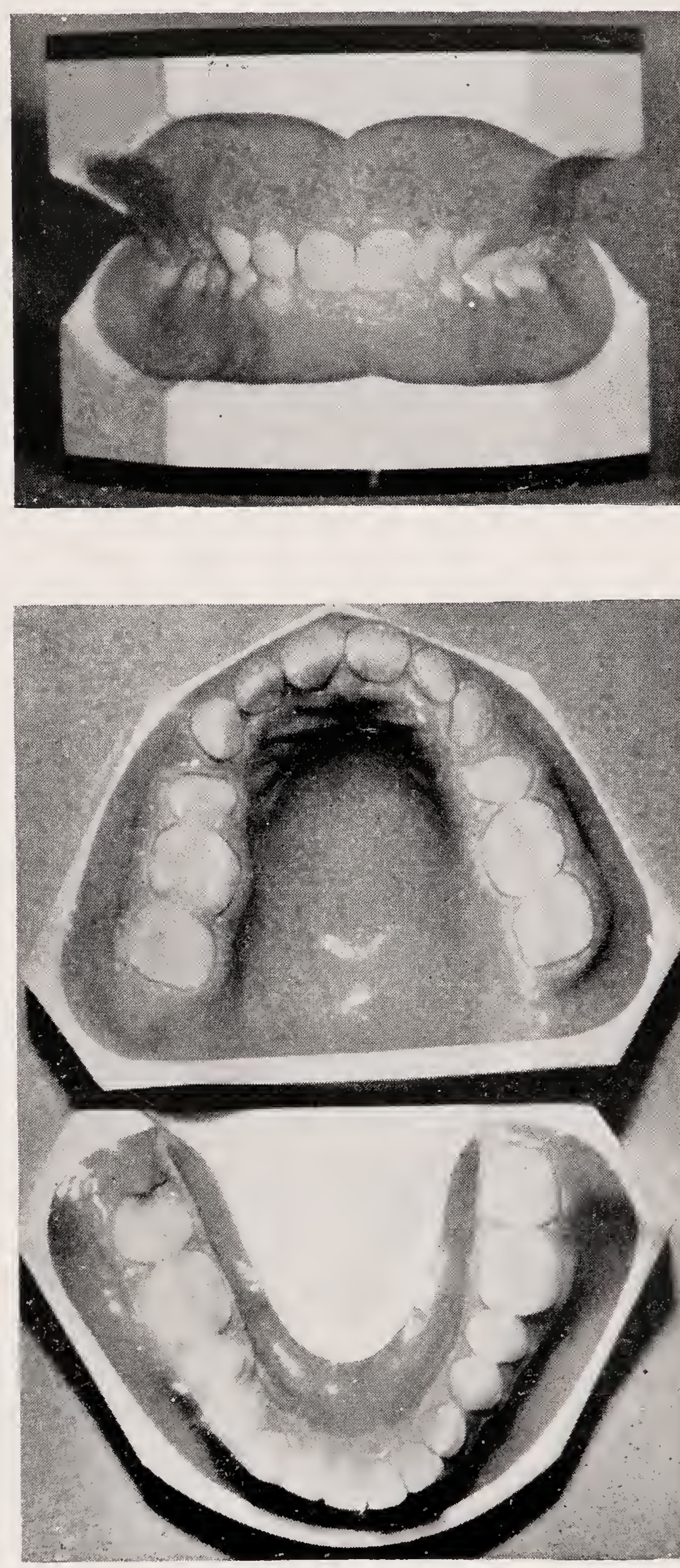


FIGURE 2

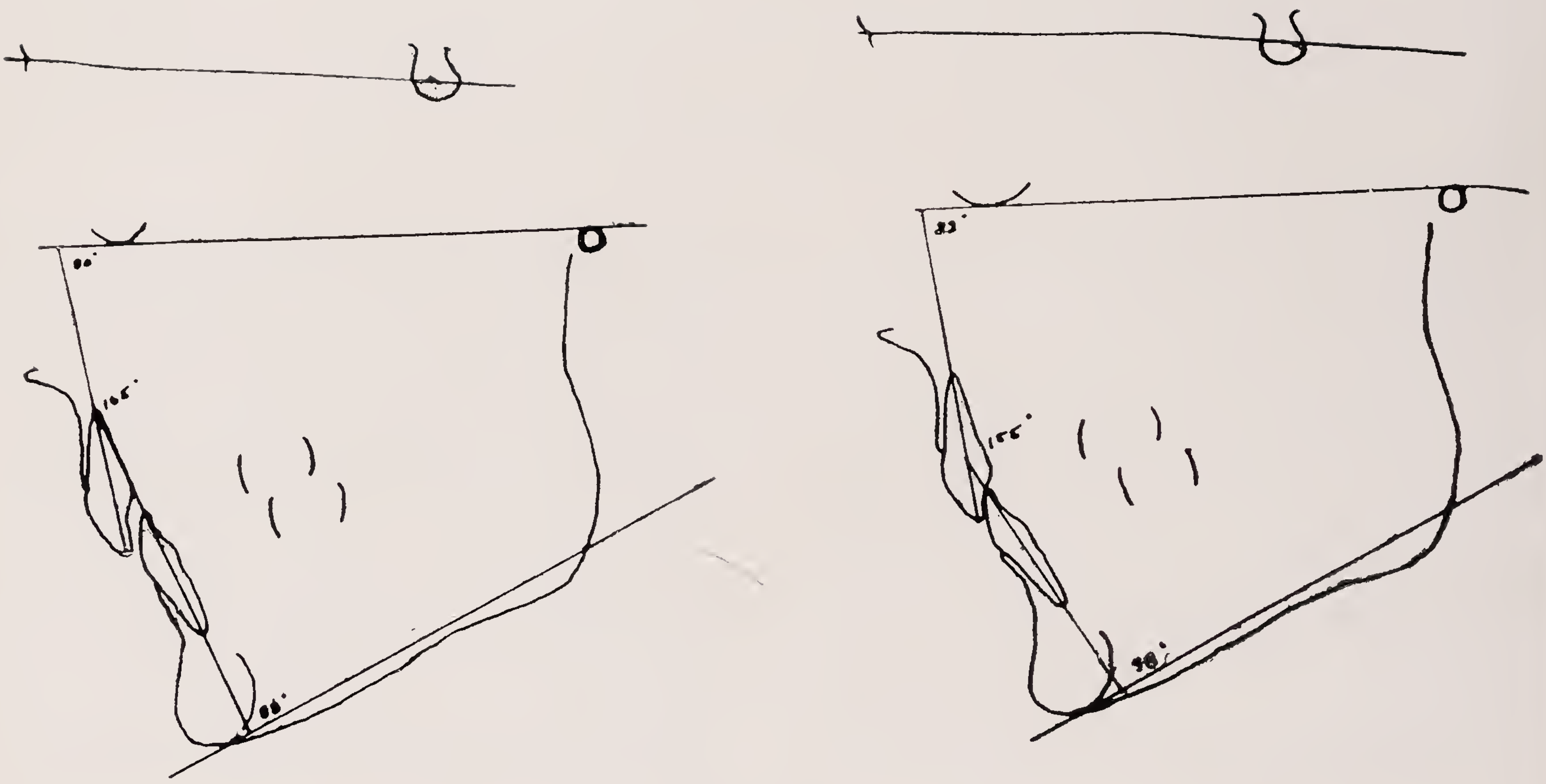


FIGURE 3

second permanent molars. By so doing, the premolars are allowed to occupy a favourable position in the arch and an exaggerated curve of Spee is corrected.

Removable Appliances

The basis of these appliances is the attachment of the acrylic foundation to the teeth, usually $\overline{\mathbf{6}|\mathbf{6}}$, by means of the 'Adams Clasp' (0.7 mm. S.S. wire) previously described at a demonstration meeting.

The function of the first two appliances (fig. 4) is mainly a distal movement of the 6|. The force arises from a split plate joined by a screw of the Glenross or Badcock type in the one, and U-loops (0.7

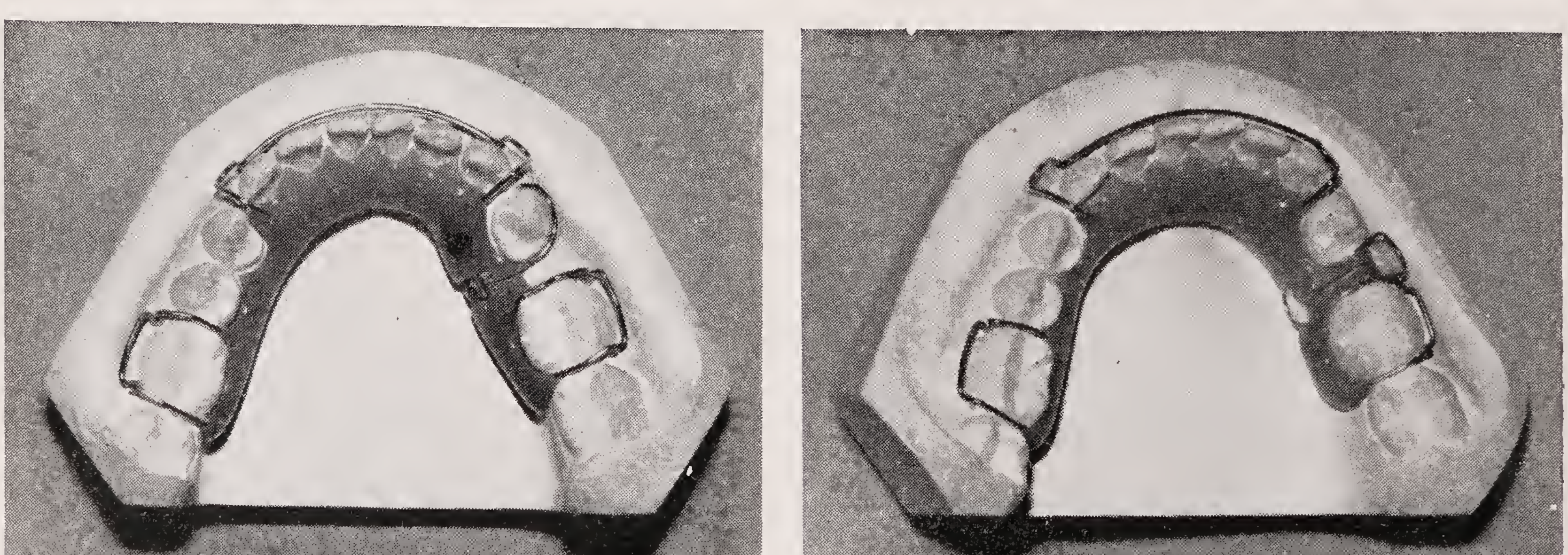
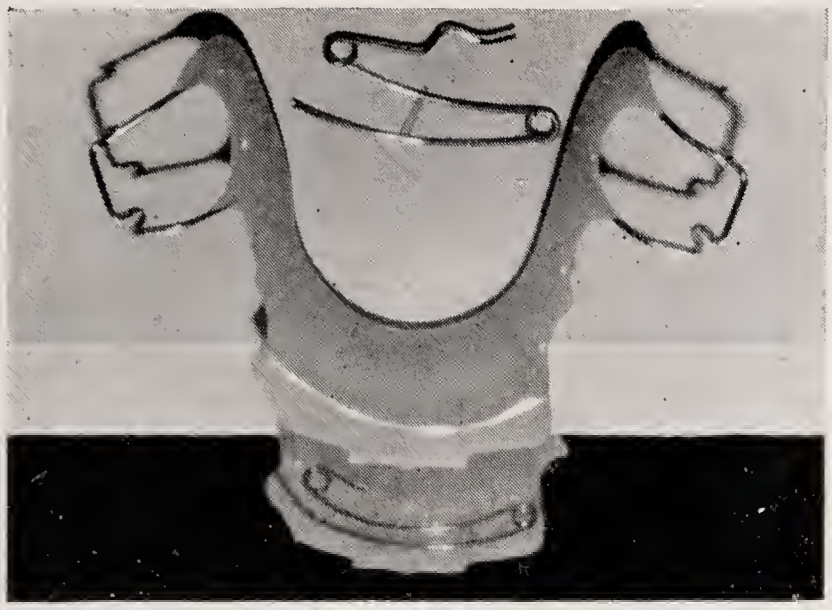


FIGURE 4



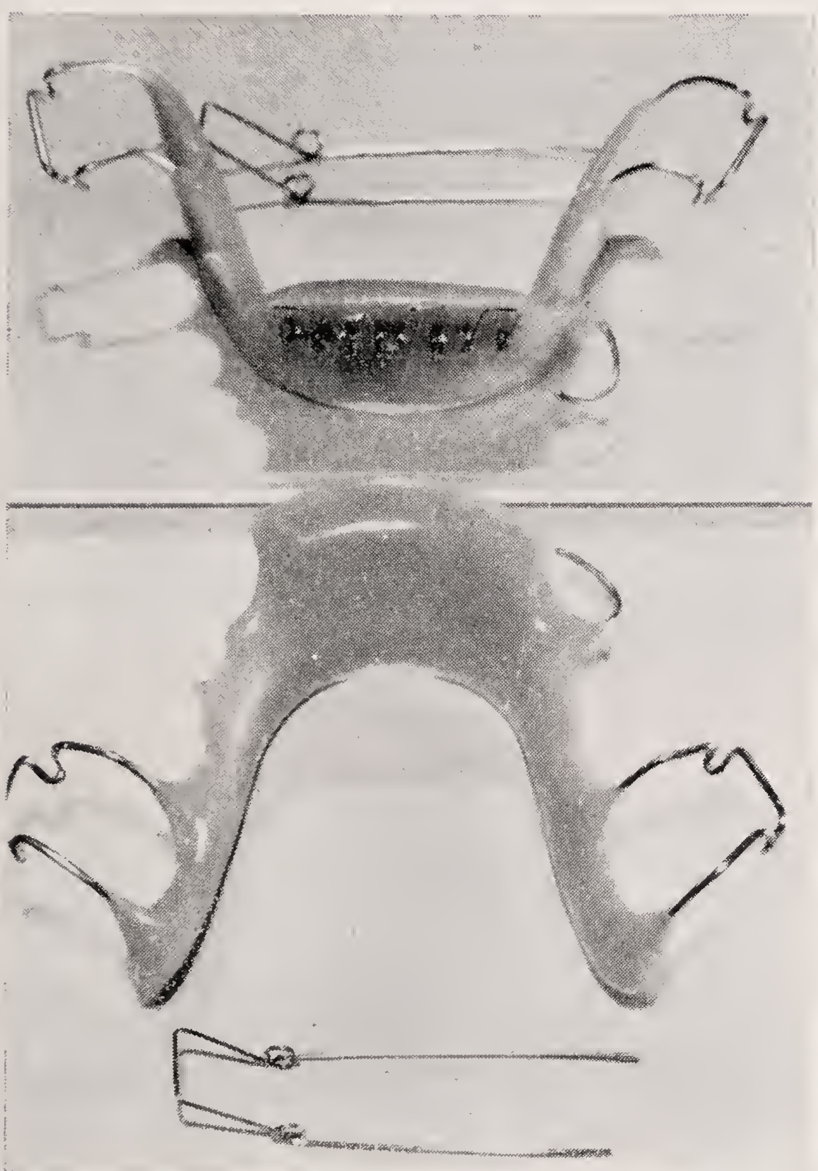


FIGURE 5

mm.) bucally and lingually placed in the other. The screw is turned once a week by the patient, and the U-loop opened up about once every three weeks by the orthodontist.

The action of the next two removable appliances (fig. 5) is mainly a forward movement or proclination of the incisors; by means of the double spring (0.5 mm.) in the one, and the flapper springs (0.35 mm.) in the other. The latter type of springs is useful when a depression as well as proclination of the incisors is required. These flapper springs may also be employed on the Norwegian plate (fig. 6).

Fixed Appliances

All these appliances arise from bands (5 x 0.15 S.S. tape) on the 6/6.

The first group are designed for a distal

FIGURE 6

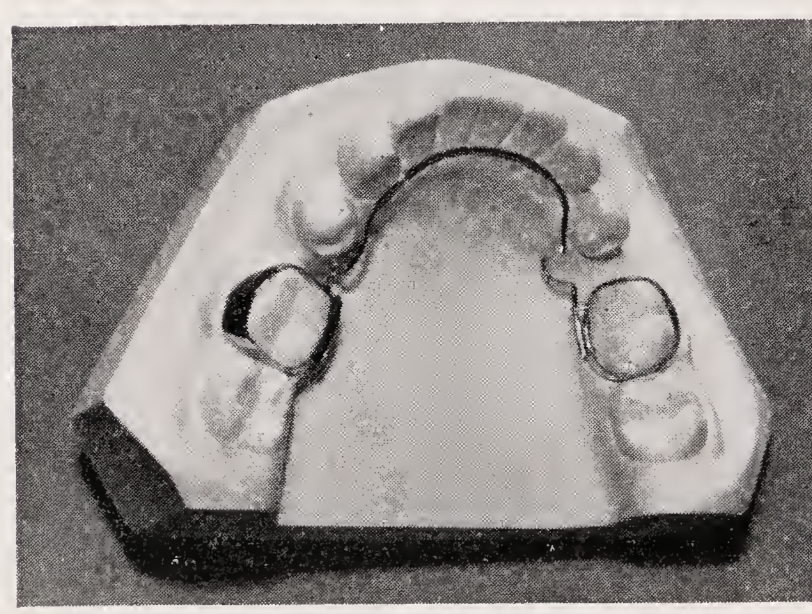


FIGURE 7

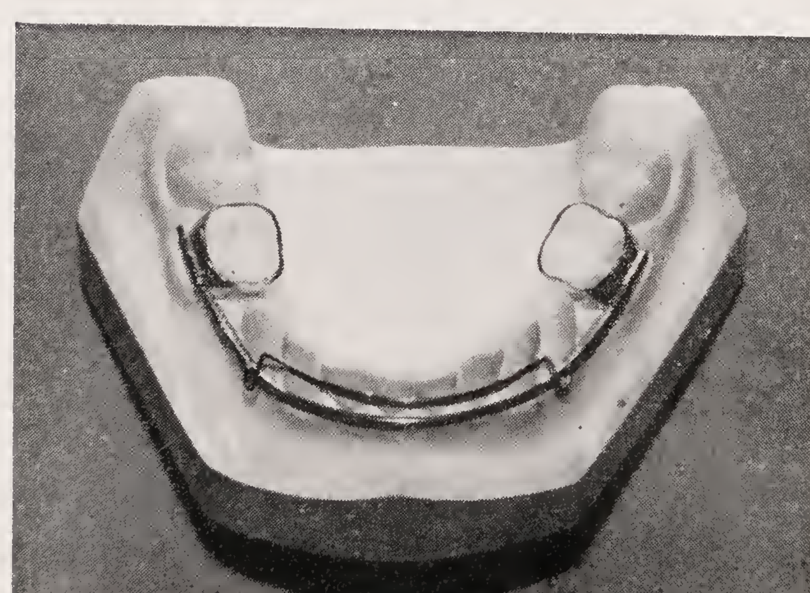


FIGURE 8

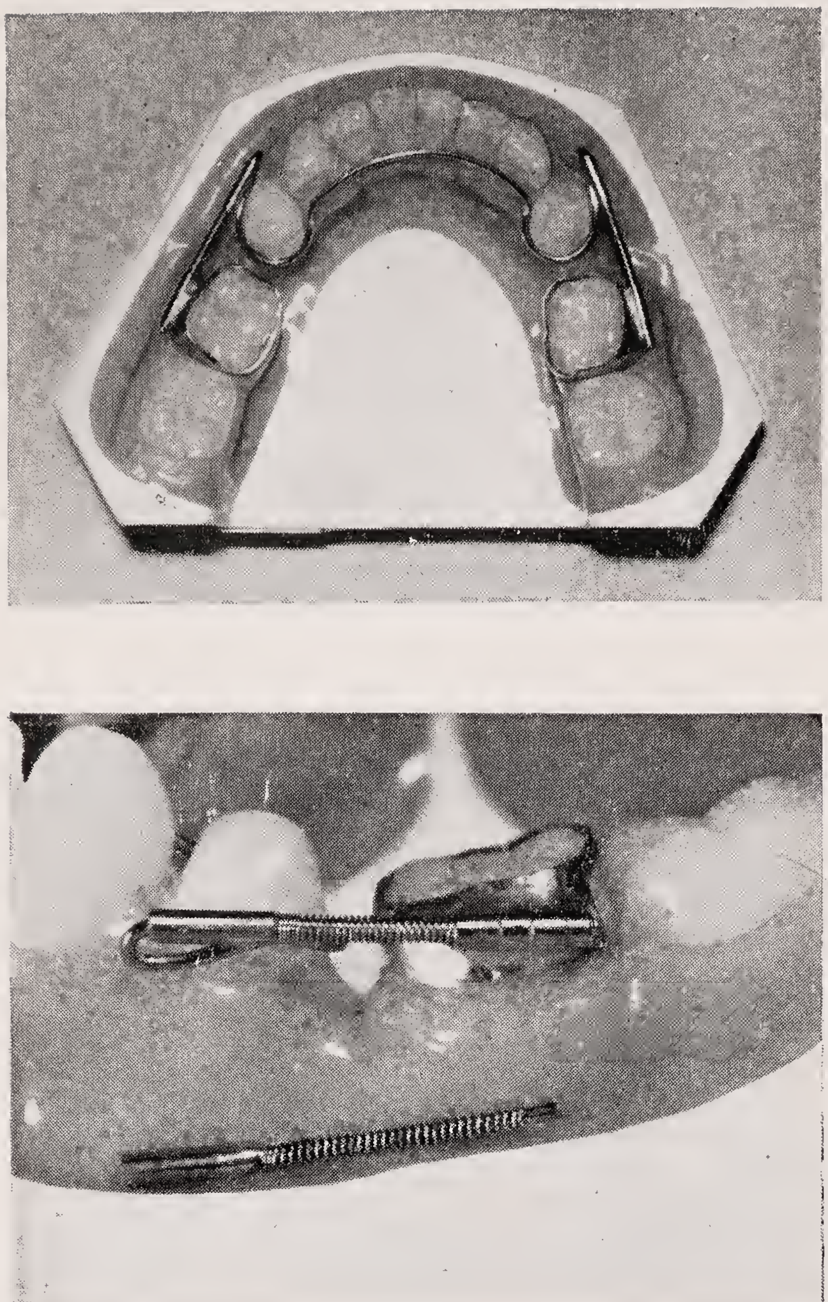


FIGURE 9

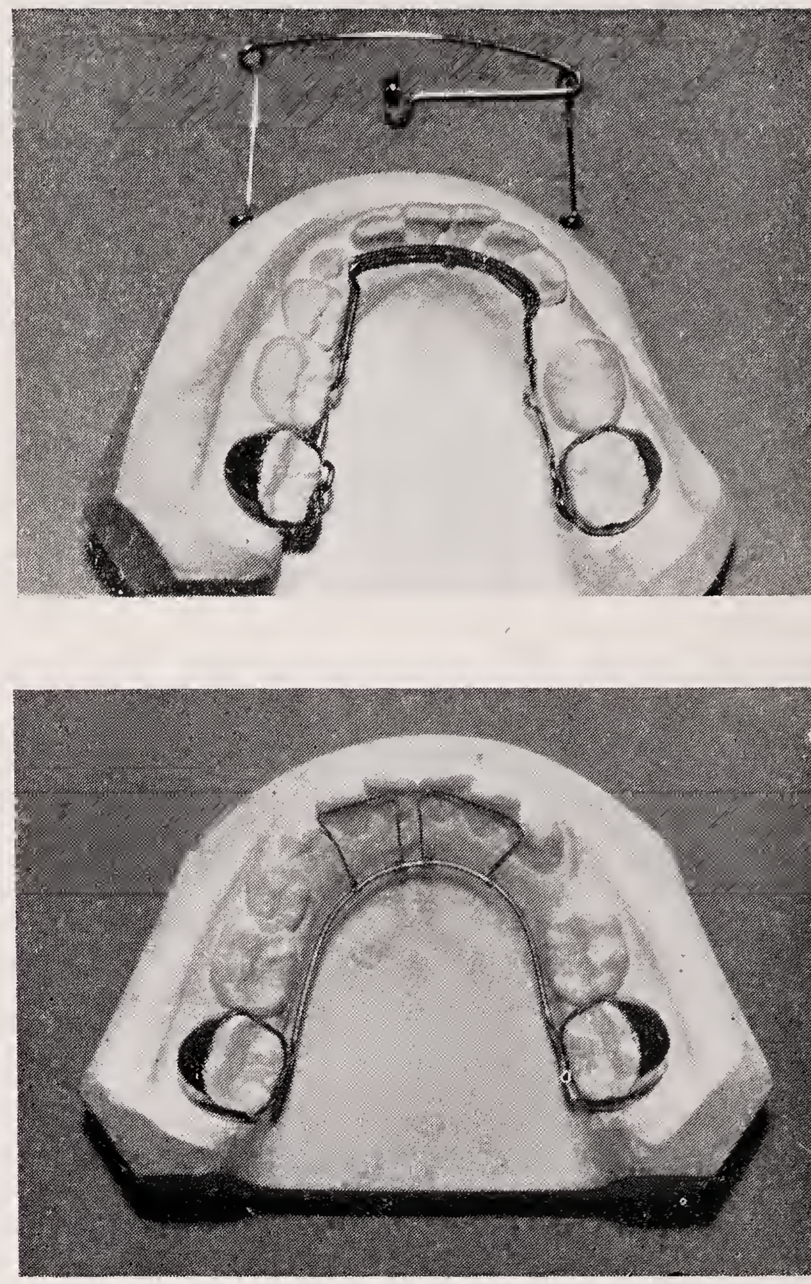


FIGURE 10

movement of the molars as much as a proclination of the incisors.

In the first (fig. 7) the lingual arch is made from 0.7 mm. S.S. wire, with U-loops which are opened up regularly by the orthodontist. In the second (fig. 8) the force arises from coiled springs (0.2 mm.) placed bucally on a labial arch and fender sliding in buccal Selmer-Olsen tubes. This arch is ligatured to the canine and incisor teeth. Buccally placed coiled springs also form the active force in the third appliance (fig. 9). The lingual arch fits into short pieces of tubing welded to sectional arches (0.8 mm.) which slide in the tubes on 6/6.

The second group act mainly by proclinating the incisors (fig. 10).

Each appliance consists of a main lingual arch (0.8 mm.) with a Friel spring (0.4 mm.) in the one and flapper springs (0.35 mm.) in the other. An advantage of the latter appliance is that the low lingual arch is welded directly on to the 6/6 bands and is invaluable where the molars are insufficiently erupted to tolerate large attachments on the bands.

The appliances demonstrated have been evolved from a variety of sources and authors, and have been chosen for their suitability in the treatment of the collapsed lower arch. Ultimate treatment consists of the correction of faulty habits and re-education of muscle action. The services of a speech therapist may be invaluable in this respect. Extraction with or without appliances may be necessary in the upper jaw.

My thanks are due to the Photographic Department, Eastman Dental Hospital.

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A Removable Appliance for Retracting Canines

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King's College Hospital Dental School.

DURING the past two years I have been asked on several occasions to recommend a suitable removable appliance for retracting the canines after removal of premolars. For myself, I have found the movement of these teeth difficult when for some reason a fixed appliance cannot be used; I should like to describe a removable appliance that has been in use at King's College Hospital Orthodontic Department for retracting canines in about one hundred cases. My only excuse for doing this is that any addition to our armamentarium gives us more scope in dealing with each case. The appliance consists of the following parts (*see figs. 1 and 2*). A base plate (a) is fitted with an inclined plane (b) which engages the lower incisors. The inclined plane is an essential part of this appliance in that, by reinforcing the anchorage, it prevents the forward drift of the molars, together with those upper teeth that are engaged by the plate.

This forward drift is due to the considerable resistance of the canines to distal movement, and the readiness of the molars to drift forward.

On the molars are fitted Jackson cribs to which are soldered horizontal buccal tubes (c). Through each tube passes a retraction arch, which is bent in the form of a flattened ' S ' (d). This is made of 0.8mm. wire. The upper arm of the retraction arch passes through another short

FIGURE 1.
Appliance for retracting upper canines.

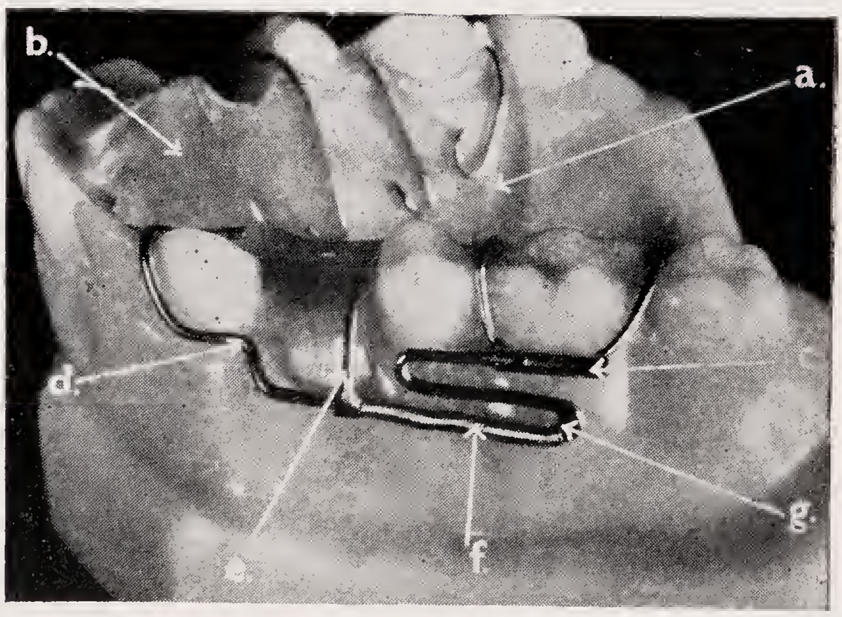
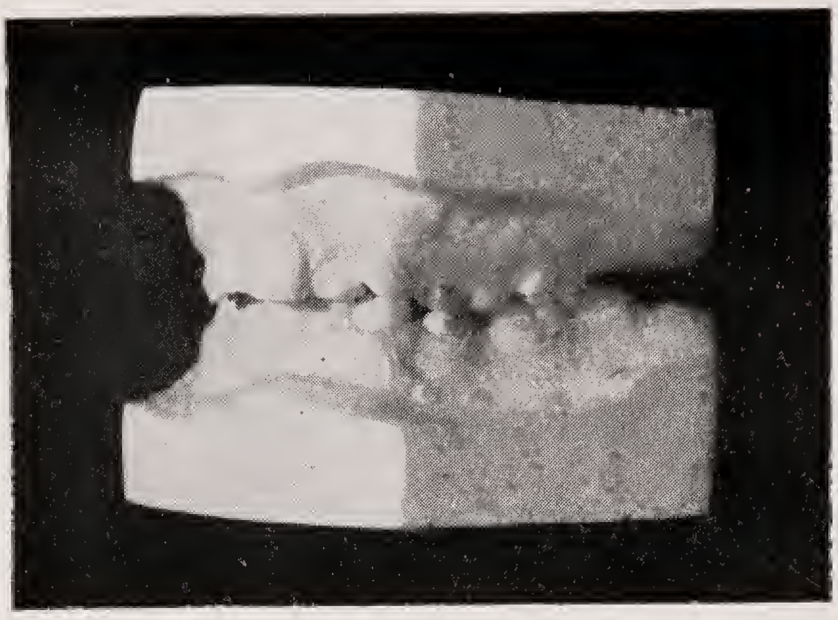


FIGURE 2.
Enlargement of Fig. 1.

(a) *Clear acrylic resin base plate.* (b) *Inclined plan.* (c) *Buccal tube soldered to Jackson crib.* (d) *Retraction arch.* (e) *Retention arm.* (f) *Coil spring.* (g) *Spot of solder as ' stop ' for coil spring.*

Short Communication presented to the meeting on 8th October.



(a)

(c)

(b)

FIGURE 3.
Case treated with retraction appliance :—
a. *Before extraction of first premolars.*
b. *After extractions and retraction of canines.*
c. *After alignment of upper incisors.*

length of tube soldered to a retention arm (e) which also holds the teeth distal to the canine from drifting mesially.

It has been found necessary to bend the retention arm so that it passes over the contact point of the premolar; this enables the canine to be retracted until it is in contact with the premolar. The retraction arch is continued forward in a loop round the canine. A short length of tube may be slipped on to the retraction arch before it is bent up, and remains free sliding. This acts as a stop at the distal elbow of the retraction arch for an extended coil spring (f), which operates also against the tube of the retention arm. Instead of the free sliding length of tube, a spot of solder (g) may be run into the elbow as a stop. The coil spring is 0.15mm. wire wound on 0.9mm. wire.

This appliance has been found to be strong, completely self limiting and to need little adjustment.

When the canines are fully retracted, the arches may be removed, the retention arms cut off, and a labial bow fitted in the buccal tubes to carry a spring for alignment of the incisors. It is necessary to incorporate clasps to retain the canines, on the labial bow.

The tension exerted by the coil spring may be varied by the amount the spring is pulled out. It should be extended only to twice its initial length. If excessive tension is used then there will be gross tilting of the canines, which may take as long as twelve months to correct.

Three pairs of models to show the progress of one of the earlier cases at King's College Hospital are shown in *fig. 3*. Four first premolars were removed, the canines retracted and later the incisors aligned. The appliance used to retract the canines is shown in *fig. 4*.

Active treatment was completed in eight months.

In *fig. 5* a modification of this appliance is shown. The buccal tubes of the molar cribs are replaced by an extra tube on the

FIGURE 4.
Appliance used to retract canines in case shown in Figure 3.

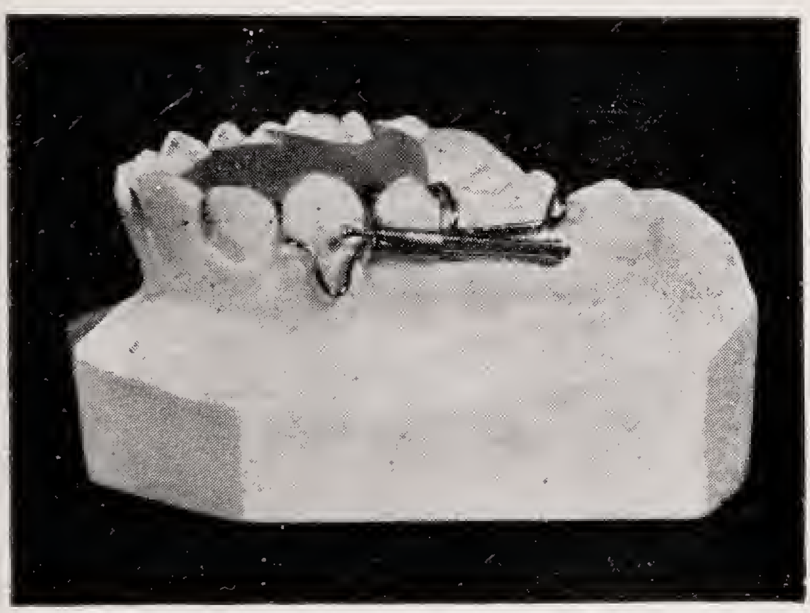
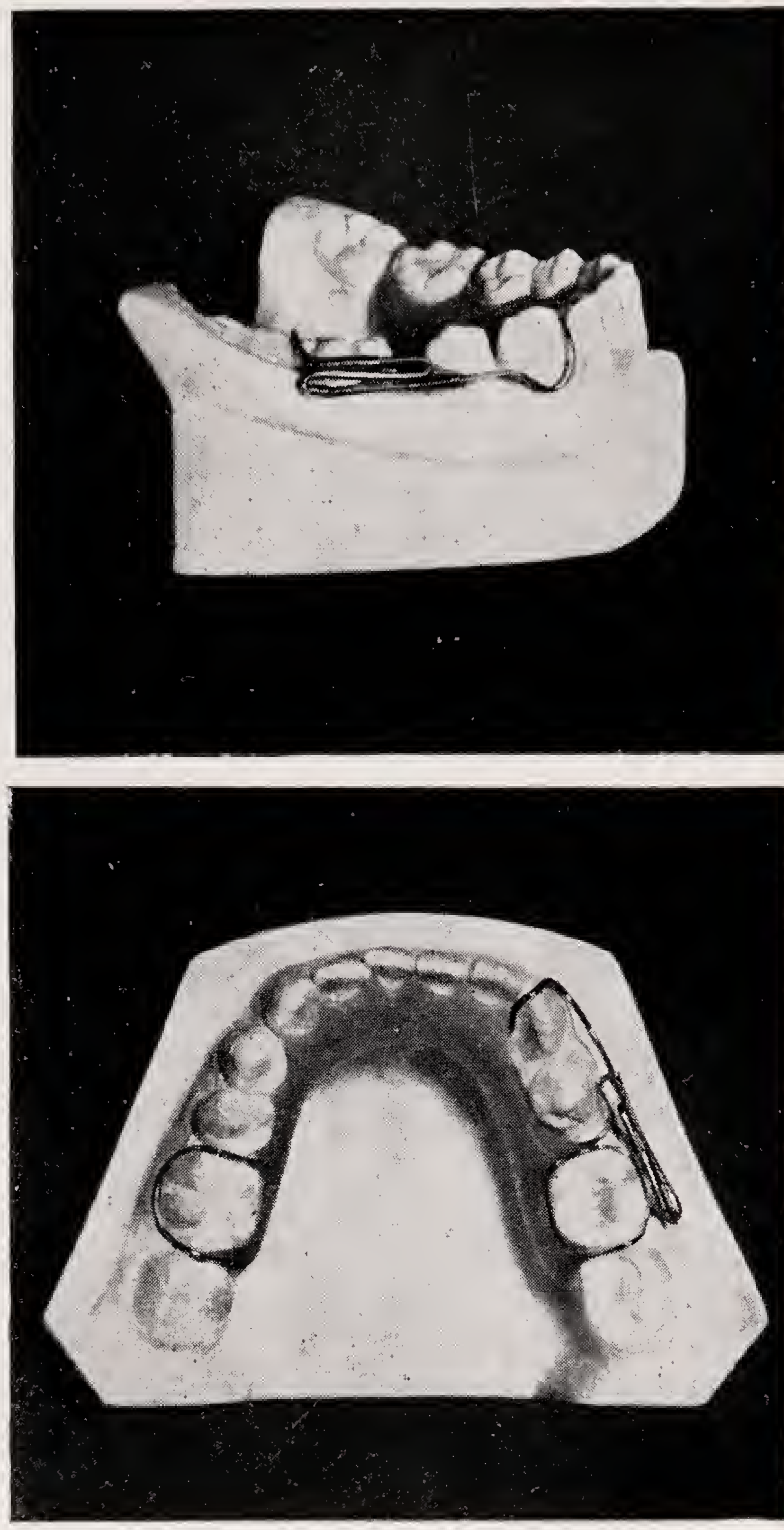


FIGURE 5.
Modification of appliance to retract upper canines.



FIGURES 6 and 7.
Appliance used for retracting lower canines.

retention arm. This has the great advantage of manouvrability of the retention arm, but cannot be adapted so easily as an appliance to retract the incisors; another small handicap is that the coil spring cannot be removed without having to remake the retraction arch.

In *figs. 6 and 7* is shown a similar appliance for use on the mandibular canines and premolars. In the lower jaw there is not the same tendency for the resistance of the canine to overcome the anchorage, partly because the labial inclination of the lower incisors is not so much as that of the upper incisors, and partly because the lower incisors are supported by the upper incisors. This type of appliance can be adapted to retract premolars.

The author wishes to acknowledge the generous help given by Mr. Russell Marsh and the staff of King's College Hospital Orthodontic Department, both professional and technical, in the preparation of this paper and by Mr. W. L. Smith and the Photographic Department at King's College Hospital in taking the photographs.

Discussion

The President said she thought that Mr. Leighton's communication was a very interesting one. The retracting of canines was, in her opinion, a very difficult operation, especially with a removable appliance. From the illustrations which Mr. Leighton had shown, it appeared that he did not get much tilting of the canines, but she would have thought that, with the pressure being so far down on the crown of the canine, the tooth would have been very liable to tilt. She would like to know whether Mr. Leighton had found that there was a danger of that happening.

Mr. E. K. Breakspear said that he would like to ask a question not about Mr. Leighton's appliance but on the subject of tilting. He had always understood that tilting of a tooth when moved depended upon where the apex had been to start with and where the crown had been at the end. He would not have thought that the amount of tension applied would have made much difference in the long run, but that opinion might be due to his ignorance, and he would like to know a little more about the subject.

Mr. J. S. Beresford said that anyone using fixed apparatus who had brought an upper first permanent molar forward would know that if he did it too quickly he would definitely tilt the tooth, whereas if he did it more slowly the tooth would not tilt.

Mr. B. C. Leighton, in replying to the discussion, said that he and his colleagues at King's College Hospital had found that there was a tendency to cause tilting, and in the early cases they had used their spring rather strongly. In six weeks they had retracted the canines over nearly a whole unit, and they had been very pleased about that until they had found that the canines tilted badly. It had taken a year to correct that tilting with a fixed appliance. He would therefore stress the fact that the spring must not be strong. If the canine was retracted a whole unit in under three months, it was being done too quickly and there would be a risk of tilting. The reason for a stronger force tilting the tooth was, he thought, histological. Work on the histology of tooth movement had shown that the fulcrum of tilting in a simple tooth movement varied with the force which was applied to the tooth. The more gentle the force the nearer was the fulcrum to the apex, and the stronger the force the nearer it was to the to the crown.

Cephalometric Radiography in Diagnosis and Treatment Analyses

A. W. Eastwood, B.D.S., M.S. (Michigan)

In 1931, Broadbent introduced a cephalometric radiographic technique for the study of changes in the human skull resulting from growth. This technique superseded previous methods, since by its use not only could external changes be noted but the associated internal landmarks could be identified as well; also, it permitted the recording of continuity of individual patterns of growth.

The head positioner designed was for the purpose of orienting the head to the source of irradiation, so that serial radiographs of the same individual—both frontal and lateral—could be produced with variables due to positioning reduced to a minimum. Using this method, changes with age, in the same individual, could then be recorded. The Frankfort horizontal plane was chosen as the plane of reference in orienting the head in the positioner, because of the relative simplicity in establishing these craniometric landmarks on the living.

Studies of serial headplates taken of children at three and six-monthly intervals when traced and superimposed in several positions, revealed certain significant observations contributing to the interpretation of the development of the faces of these children, namely; that there were certain areas in the cranial base which showed a minimum growth-change. It was concluded that those areas in the cranial base which showed least growth-change, offered a more precise basis for relating tracings and consequently a more accurate method of measuring development in the living head.

In 1937, Broadbent postulated the use of the Bolton-Nasion plane with the registration point ' R,' located in the sphenoidal area, as the relatively more stable point of orientation for the superpositioning of serial tracings. This plane was established after study of a great number of cases. The relative stability of this plane was confirmed by statistical determinations from measurements made on collections of skulls of various ages.

The plane is determined at its anterior end by the craniometric landmark known as nasion, the junction between the frontal and nasal bones in the mid plane; its posterior termination is the highest point in profile of the notches at the posterior end of the condyles on the occipital bones. It was found that the right and left condyles are close enough to the mid sagittal plane and to the path of the central ray, so that the X-ray shadows of their outlines registered on the film as a single image. From this Bolton-Nasion plane a perpendicular is erected to the centre of the sella-turcica, located by inspection, and a point midway between the plane and sella on this perpendicular, called ' R '—this point being then used as

Presented to the meeting on 8th October.

the registration point for superimposing tracings of subsequent radiographs of the same individual and of different individuals as well.

To assist in comparing evaluations of facial and dental growth by this method with the orthodox one employed by the anatomists and anthropologists, the Frankfort Horizontal plane was used. Its use, in turn, favoured the use of the perpendicular orbital plane which passes through the dentition at about right angles. Measurements taken from these two planes then constitute a record of change in relation to the more constant Bolton landmarks.

That other planes of reference have been advocated is evidenced by the work of Margolis (1940), Brodie (1941) and Bjork (1947).

McDowell (1941) in a study of lateral head radiographs of growing children showed by a series of super-impositions on different points, how all aspects of skull growth are relative. He stated: " By definition, any given position can be described only by relating it to something else. Similarly, the position of any detail in the lateral head X-ray can best be described by relating it to some other aspect of the skull. If one keeps this in mind, then certain cranial points may be considered fixed for the purpose of describing changes due to growth or treatment. But no detail of the skull as seen in a lateral head radiograph can be a truly fixed point during growth."

He further remarks that only those points should be employed which can be located with precision by several operators in successive headplates. He points out that the Bolton landmark, situated as it is, is often difficult to locate, because it requires the estimation of a point on an arc, which moreover may be obscured after three years of age—both by the mastoid eminence and the neck musculature.

Brodie (1941) in his study on the growth of the skull, used the anterior part of the cranial base for orientation, namely, the plane sella turcica to nasion. In favour of this method is the precision with which this plane can be established.

At present, however, the widely accepted plane of reference is the Bolton-Nasion. On the postulate of the relative stability of this plane at the base of the cranium during growth, many investigations using serial X-rays have indicated the inter-relation of the various parts of the skull in a downward and forward pattern of growth, from childhood to adulthood.

This inter-relation of the developing parts of the face and skeletal structures which could be recognised both in individuals and among them, made it possible to establish profile dento-facial patterns representative of age. These are now known as the Bolton standards of developmental age.

Since their establishment, many workers in the field have used them as a basis from which to enquire still further into the growth of associated parts for the purpose of obtaining more detailed information concerning dysplasias of growth in cases of facial disharmony and malocclusion.

In many of these studies, growth of the associated structures was studied in terms of planes and angles related to the " fixed " points and planes of the Bolton study.

In evaluating the results of such studies, based as they are on the use of certain registration points, one may well ask: ' What is to be the measure of validity of any plane used? ' It is in attempting to answer this question that cephalometric workers fail to agree.

Some always superimpose on the point ' R ' with the Bolton planes parallel, while others prefer to superimpose uniformly on the line ' S-N,' with sella registered; however, strict adherence to either one of these principles—or to some other one for that matter—would occasionally lead to interpretations inconsistent with common-sense.

A complete discussion of registration points would entail a discussion of growth

sites, of sutural activity and the methods used in investigating biological activity as it affects the growth and development of the skeletal structures. Such investigations have furnished data on this subject but much remains to be done, and until the biological activity which causes the changes in dimension of the skull is fully understood—both as to its mode and timing—the blind acceptance of any one method of super-positioning can well lead to conclusions that are not only inconsistent with common-sense but scientific reasoning as well.

The choice of registration points for the purpose of superpositioning tracings of serial radiographs is often dependent upon the particular investigation which is being followed; it may be the study of a particular phase of the growth process or a treatment analysis. For example, one cannot judge what has taken place with respect to the mandibular plane by using either the Bolton or ' S-N ' method. In this latter case, it would be more appropriate to superpose on the lower border of the mandible with the sagittal section of the symphysis registered. The section is used in preference to the chin point, since appositional growth in this area may lead to inaccurate superpositioning.

The use of the ' S-N ' or Bolton methods of registration is of value in indicating the amount of growth which has taken place in the cranium and the *total* changes in the face—particularly in the profile. It is however valueless for indicating changes which have taken place in the maxilla with relation to the maxillary base or in the mandibular structures with relation to maxillary structures.

Tracings superimposed on the line of the hard palate with the anterior nasal spines registered will enable the operator to evaluate the amount of growth which has taken place in the intervening period of time and the amount of movement achieved as a result of treatment. While this method does not give a clear-cut definition between the changes due to growth and those resulting from treatment, the use of this method of registration does tend to eliminate any effects of growth which may have taken place between the anterior cranial base and the hard palate.

It should however be appreciated that in order to elucidate a particular point, either of growth or treatment analysis, the decision on the choice of registration points to be used is often a difficult one, especially when more than one method seems possible. The final choice may in the end be governed by it being, after all, the best possible one in view of the limitations of our present knowledge of the process of growth and the biological activity causing it. When it is realised that any method of superpositioning—dependent as it is on the use of registration points—has very definite limitations, conclusions on the results of such work must of necessity be cautious; as to over-extend in the interpretation of cephalometric films is as much an error as to trace structures which are not clearly defined on the original headplate.

The orthodontist is called upon to diagnose and prognose treatment in individuals who present disharmonies of facial outline and irregularities of the dento-facial complex. If he is to be in a good position to do so, not only must he understand the influence of those factors involved in the production of the disharmonies, but also the extent of possible variation within the organism, which may yet in the end produce satisfactory balance between the associated parts for the adequate functioning of the total whole—even though some arbitrary standard has not been duplicated.

It should be remembered that we are looking not so much for a concrete expression of what is normal, either from an occlusal or skeletal point of view, but instead, comparing a single patient with known limits of acceptable variation. Morphological variation is wide; rigid

FIG. 1. SKELETAL PATTERN

1. Facial angle.

Formed by the intersection of the facial plane (N-P) with the Frankfort Horizontal (F-H).

Tends to be smaller in Class II than in Class III tendencies.

Minimæ 82.0°; average 87.8°; maximæ 95.0°.

2. Mandibular plane angle.

Formed by prolonging the mandibular plane (M-P) to intersect with the Frankfort Horizontal.

This angle is large in unfavourable facial patterns.

Minimæ 17.0°; average 21.9°; maximæ 28.0°

3. Y axis (growth axis).

Measured as the acute angle formed by the intersection of a line from sella to gnathion (S-GN) with the Frankfort Horizontal (F-H).

This angle is larger in Class II facial patterns than in those with Class III tendencies.

Minimæ 53.0°; average 59.4°; maximæ 66.0°.

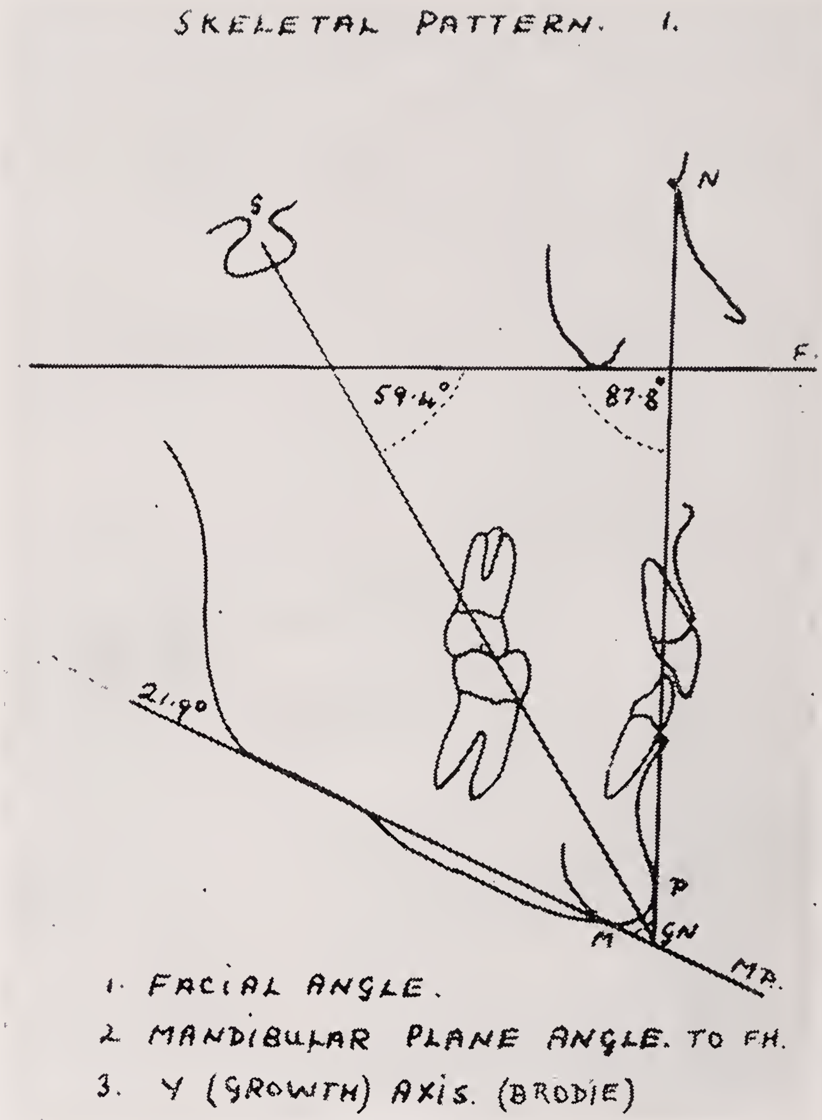


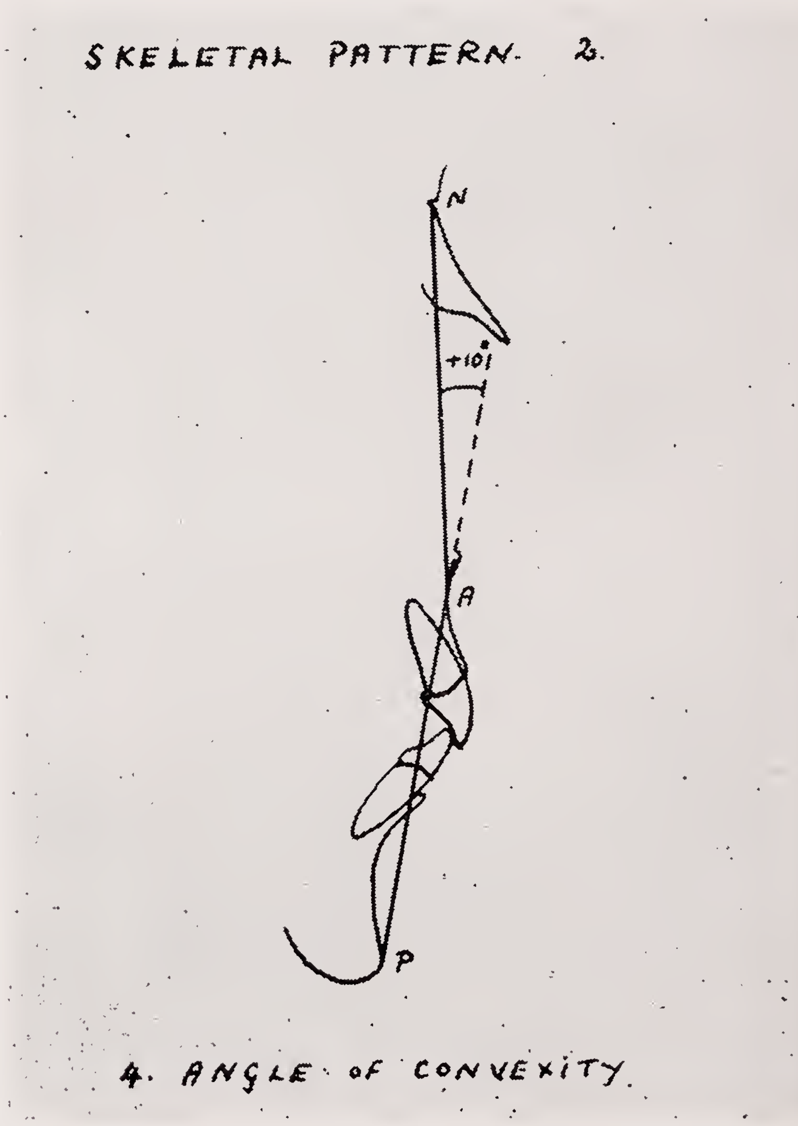
FIG.2 SKELETAL PATTERN

4. Angle of convexity.

A measure of the antero-posterior position of the maxillary denture base in relation to the rest of the profile.

N and A and A and P are connected with straight lines. P-A is prolonged (dotted line) and the angle with N-P is read. If the extension of P-A lies anterior to N-A, the angle is called ‘positive’: if it lies posterior, the angle is ‘negative.’

A negative angle of convexity is associated with a prognathic profile; large positive angles, with relative prominence of the maxillary denture base.



standards are impossible to establish, even if such standards were desirable. Even the expressions of " good " or " poor " should be applied with caution, for they may only be the citation of individual preference, having little to do with the functional aspect of occlusion or the longevity of the dental apparatus.

The cephalometer is a quantitative instrument, thus it should lend itself well to the expression of variation in quantitative terms—terms which would be more readily understood and evaluated by the young orthodontist lacking in experience.

Results of such investigations carried out by Downs (1948), Björk (1947), Thompson (1949), have been expressed in quantitative terms by means of statistical determinations. Brodie (1946) clearly stated the limitation which must be placed on the interpretation of such data when expressed in the statistical terms of means and ranges. He pointed out that such figures should not be interpreted as absolute values, so that any one individual who did not exhibit them was not normal in his development.

Statistics will yield very definite information about the groups studied, but when these figures are applied to an individual, they must not be taken as absolute values, but rather interpreted in the light of range within which a so-called ' norm ' may operate.

Since orthodontists are prone to classify facial types according to the degree of recession or protrusion of the mandible, it would obviously be an advantage to study skeletal patterning in a manner consistent with facial type.

Downs (1948) in his analysis, has expressed in quantitative terms ten different facial and skeletal characteristics—thereby making it possible for the young orthodontist, who follows this analysis, to judge to what extent the facial pattern of the individual corresponds to or varies from facial patterns possessing sufficient harmony to make possible excellent occlusal relationships.

When using this method of appraisal in an individual, one determines the ten different values for the patient from an oriented lateral head-radiograph and compares them each in turn with the group average and the maximum and minimum extremes as shown in the table of results, from Downs's group study. These results were expressed to ± one sigma range. However, the author was informed that ± two sigma range is a closer approximation to the acceptable range of normality, according to the Downs's investigation.

The ten different determinations are established as shown in *figs. 1, 2, 3, 4, 5.*

In order to compare the facial pattern before and after orthodontic treatment, it is not enough just to make two independent analyses and find the arithmetic difference between them. A complete evaluation can only be carried out by superposing the before and after tracings in order to make an estimate of how much of the change is due to growth and how much to treatment, using several methods of registration to clarify the associated areas under the influence of treatment.

When comparing before and after tracings, care must be taken that those points which are definitely not influenced by treatment, i.e., Nasion, sella, Bolton, are located on the second tracing precisely as they were on the first; it is in fact a point-for-point transference of these points from the first to the second tracing. Such points as 'A' and ' B ' which are influenced by treatment are located independently on each tracing.

It will be noted that in Downs's analysis the Frankfort Horizontal is chosen as a plane of reference in showing the degree of protrusion or recession of the chin, expressed in terms of the Facial Angle. This reading is indicative of the facial type. The validity of choosing this plane as against cranial planes was shown by

FIG. 3. SKELETAL PATTERN

A-B plane—Facial plane angle.

A measure of harmony in the antero-posterior positions of maxillary and mandibular denture bases.

Points A and B are joined and extended and the angle formed with the line N-P is read in much the same manner as the angle of convexity (*fig. 2*). Since point B nearly always lies behind point A, this angle is usually negative in value, except in Class III cases or in Class I's, with definite prominence of the mandible. A large negative value suggests a Class II facial pattern.

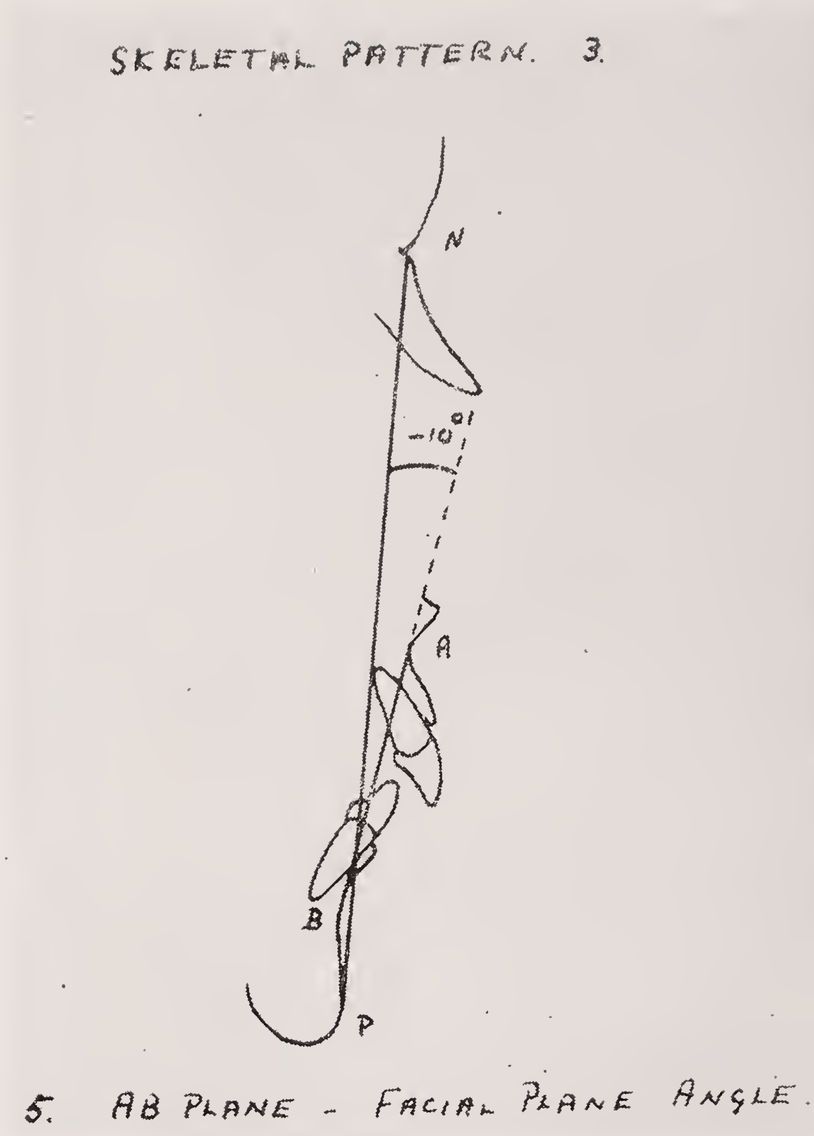


FIG. 4. DENTURE TO SKELETAL PATTERN.

1. Cant of the occlusal plane.

   Measures the slope of the occlusal plane by the Frankfort Horizontal (F-H). It is established by the intersection of the posterior extention of the occlusal plane with the Frankfort Horizontal (F-H). When the anterior part of the plane is lower than the posterior, the angle is called ' positive '.

   Larger positive angles are found in Class II facial patterns.

2. II to II Angle.

   Established by passing a line through the incisal edge and the apex of the root of the maxillary and mandibular central incisors—thereby establishing their long axes, and measuring the angle so formed.

   This angle is relatively small in individuals where incisors are tipped forward on the denture bases.

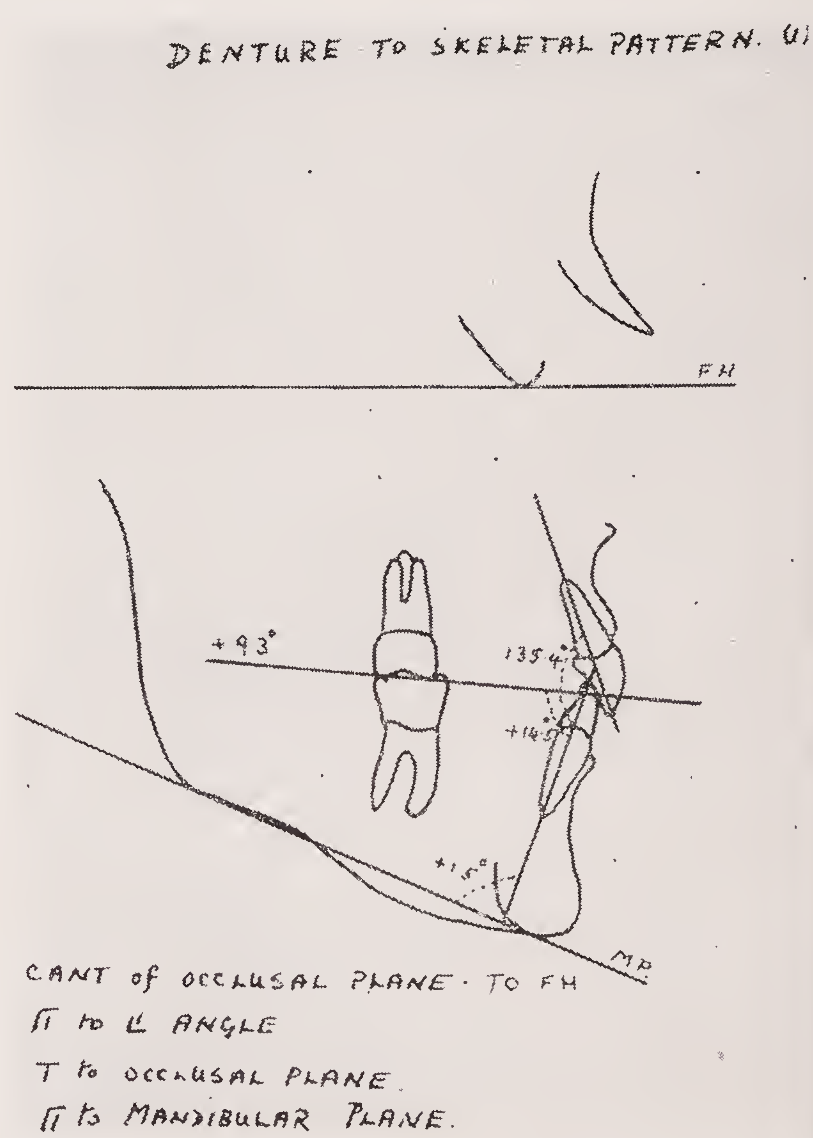
3. I to occlusal plane.

   Formed by the intersection of the long axes of the lower incisor with the occlusal plane. The inferior angle is read as a plus or minus deviation from a right angle; (i.e., the complement). This relates the mandibular anterior teeth to a functional plane, and positive values increase as these teeth incline forward.

4. II to mandibular plane.

   Formed by the intersection of the long axis of the mandibular incisor with the mandibular plane.

   This angle is positive when the incisors are tipped forward on the denture base.



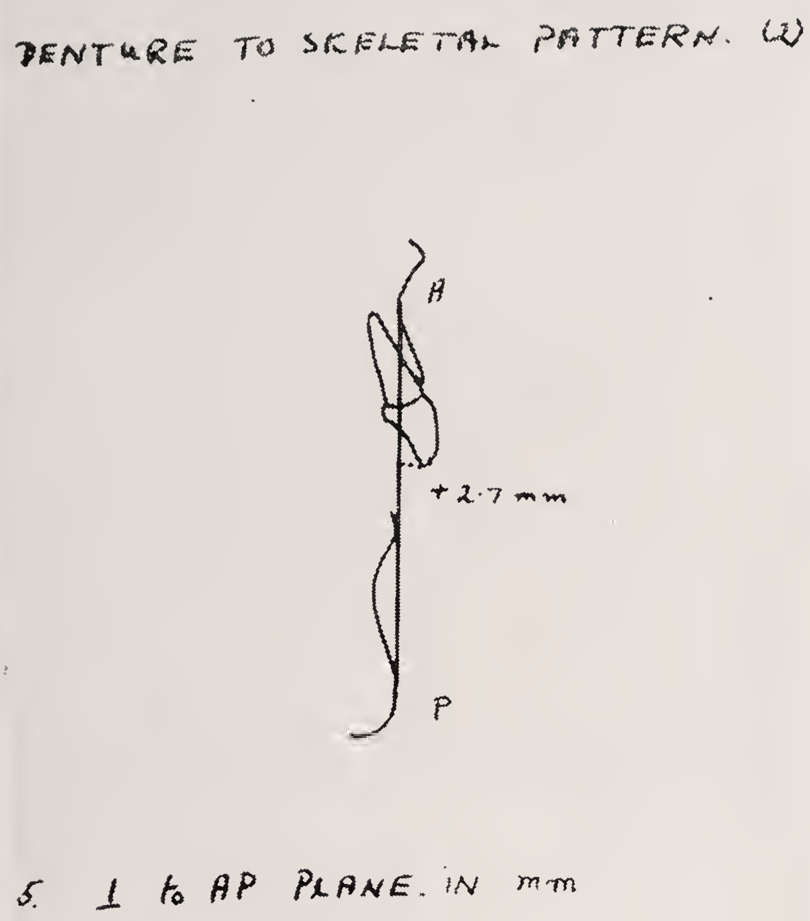


FIG. 5. DENTURE TO SKELETAL PATTERN

I to A-P plane (m.m.)

The distance from the incisal edge of the maxillary central incisor to a line connecting point 'A' with pogonion. The distance is positive, unless the incisor lies behind the line A-P.

Downs on statistical analyses in comparison to the cranial planes 'S-N,' and Bolton.

In addition, whereas the 'S-N' and Bolton planes form dividing lines between the face and cranium, the Frankfort Horizontal cuts across the face and would thus appear more valid in studies involving the face alone. It should, however, be remembered that—according to the Bolton group study—the Frankfort Horizontal plane was shown to change its relationship to the Bolton-Nasion plane during growth; also a degree of doubt exists as to the ability to register the craniometric landmark of porion, in an indentical manner on successive radiographs.

To overcome this latter difficulty, Downs recommends that the Frankfort Horizontal on the tracing of the second serial radiograph be drawn in when the two tracings are superposed on 'R,' with the Bolton planes parallel, using the orbitale of the second tracing, but drawing the Frankfort Horizontal from this point parallel to the Frankfort Horizontal on the first tracing, irrespective of where porion is situated on the second radiograph. In this manner a constant relationship between the 'F-H' and Bolton planes will be maintained in both tracings.

An additional method of cephalometric appraisal has been advocated by Thompson and co-workers at North-Western—reported by Graber (1949). In comparison to Downs's work, it will be noted that this method involves eight determinations and does not make use of the 'F-H' plane as a plane of reference, *fig. 6*. Instead the cranial base plane 'S-N' is used, as some investigators feel that the 'S-N' plane is more stable and more readily picked up in serial headplates, with less variation of the terminal points of this base plane.

In this method, the angle of convexity (Downs) is represented by Nasion-Point

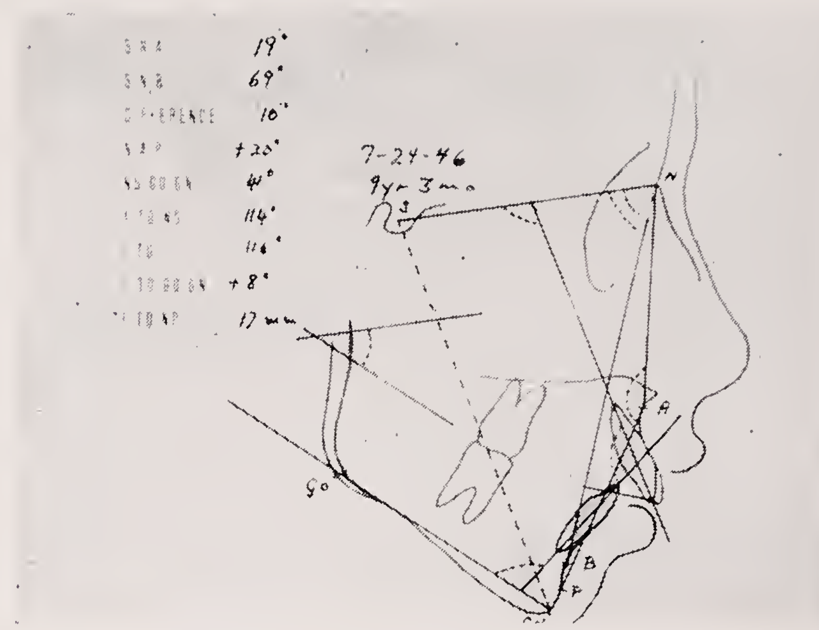


FIG. 6.
Illustrating the eight main determinations used in the Thompson method of appraisal.
The determinations are explained n the text.

'A'-Pogonion (N-A-P) and in " normal " profiles this angle is actually a straight line or slightly convex (Reidel); it shows the degree of concavity or convexity of each profile. A minus reading indicates a deficient maxilla antero-posteriorly (e.g. cleft palates) or a mandibular prognathism.

Sella turcica-Nasion-Point 'A' (S-N-A); an angular measurement, which is used to determine the relative antero-posterior position of the maxilla at the junction of the alveolar process and basal maxillary bone (Point 'A,' Downs).

Sella turcica-Nasion-Point ' B ' (S-N-B); is a more accurate means of appraising the mandibular denture itself in relation to the face as a whole, independent of any modelling bony accretion, which can be found on the chin point in some cases; thus the angular measurement, sella-Nasion-gnathion would not be a true representation of mandibular denture base relationship.

The angular difference between ' S-N-A' and 'S-N-B ' is indicative of apical base relationships between maxilla and mandible and is perhaps one of the most important criteria in orthodontic diagnosis. The larger the difference, the more difficult it is to adjust the occlusion and maintain the integrity of relationship of the teeth to basal bone.

The angle ' S-N ' to the mandibular border ' GO-GN '—gives relatively the same information as the angle between the ' F-H ' plane and the lower border of the mandible; it cannot however be estimated by inspection. The angle of the maxillary central-incisor to ' S-N ' plane is directly under the influence of orthodontic therapy and indicative of balance, or lack of it, in the incisor segment.

The measurement of the perpendicular distance from the tip of the upper central incisor to the facial plane, or ' N-P,' has little value by itself but should be correlated with the inclination of maxillary and mandibular incisors, to their basal bone and to each other—as well as the presence or absence of spacing in the anterior segment, noted as part of the routine clinical examination.

The facial angle is here represented as ' S-N-P,' in which the facial plane ' N-P ' is related to the cranial base plane ' S-N,' as against the ' F-H ' in Downs's method.

The angular relationship of the long axis of the maxillary and mandibular incisors is again a means of appraising incisor to incisor relationship, and should be correlated with those criteria assessing tooth to basal bone relationships.

It will be noted, however, that in this analysis the Y Axis (or Growth Axis) represented as the line joining sella turcica to gnathion is not used. This axis

of growth, as described by Brodie (1941) has been shown by Downs to form an average angle of 59.4° with the Frankfort Plane. The face is said to grow in a downward and forward direction from under the cranium from birth to maturity; thus, if the Y axis is representative of the directional nature of this growth, then a change in the angular measurement will be indicative of the timing and direction of this growth. It may show that either the horizontal component is exceeding the vertical—in which case the angle will diminish—or the vertical component is exceeding the horizontal—in which case the angle will increase. If, however, the angle shows no change then both components are equal. This information is of value, since the orthodontist has little control over skeletal patterning in treatment; but, to have an indication of the directional nature of growth—both during and after treatment—would be of great value in the decision as to the treatment and its prognosis.

The range of normality of skeletal and denture patternings as shown by the work of Downs, Thompson and Reidel has been expressed statistically in table form.

When these determinations are used as a basis for comparison in a particular case, the age of the patients used in arriving at the range of normality is of great importance. It has been shown by Björk and Schaeffer and others that changes in skeletal and denture patterning do occur during growth, thus to compare a child with a range of normality evaluated from the study of older patients may lead to erroneous conclusions. Baum has stated: " The child must be compared to a normal range compiled for his own age group and not to one of an adult or older age group. Similarly, the ideal of treatment should be a denture pattern within the normal range for the particular age group of the patient, within the limits of the skeletal pattern, again evaluated by comparison to a normal range for that particular age group." He suggests that in view of this it is necessary to establish a series of progressive normals, one for each age group throughout the growth period.

The two analyses, in order to be of value in the scheme of orthodontic diagnosis and prognosis, are not sufficient in themselves; rather they form but a part of, and are complementary to, what we can call our clinical examination of the patient. Such factors as arch length, which refers to the teeth in contact rather than the basal bone, muscular balance of the facial musculature—and other valuable information resulting from the purely clinical examination of the patient. However, a cephalometric analysis can give an indication of the underlying skeletal pattern; information which may well indicate the limitation of orthodontic treatment in a particular case by showing where the disproportion lies.

Downs has stated that " Patients seek orthodontic treatment because a malocclusion is present. They may have aesthetically harmonious and functionally balanced facial musculature; or they may present varying degrees of dis-harmony and imbalance. If the former condition is present, the headplate analysis will give readings either within the normal range or with only slight deviations. As these cases do present good muscle balance, it would be desirable not to destroy this by placing teeth in unfavourable relationship to the skeletal pattern. In those cases with poor functional and aesthetic balance, the fault will be in a poor skeletal pattern or in a faulty relationship of the denture to the skeletal pattern; or both conditions may be present. The cephalometric readings will locate and give the amount of disproportion."

In a functional analysis of malocclusion as distinct from the earlier static method, the cephalogram is of great value since it directs attention to the whole of the masticatory mechanism and its functional

relationship to the rest of the skull, and soft tissues.

It has been—and to some extent still is—the practice to form a diagnosis of a particular case purely on the basis of articulated dental casts. Thompson (1946), in his study on the rest position of the mandible, has shown how the occluded relationship of dental casts can in fact present an erroneous relationship when the case is analysed in terms of the mandibular rest position.

This position is established at birth before the teeth erupt, by muscle balance; it remains unaltered after the teeth erupt.

When the face is at rest there is a slight separation between the upper and lower incisors, usually between 2-3mm. The path of closure of the mandible to the occluded position is approximately a hinge-like movement, *fig. 7*; and occlusal interference—which prevents this path of movement—may cause mandibular displacement either to one side or the other of centric bite, or a postero-superior displacement resulting in what to all intents may be a dist-occlusion, *fig. 8*.

By analysis in terms of the rest position and the path of closure, a distinction may be made between the apparent and true Class II type malocclusions; this will of necessity have a direct bearing on the prognosis of any treatment suggested in such cases.

The extent of the free-way space is of great importance in those cases where the Andresen method of treatment is advocated and also when any other form of bite-plate is used, *fig. 9*. More especially when they are advised as night-wearing appliances only.

Thus a cephalometric analysis of the face at rest can aid the orthodontist in establishing a more balanced occlusion by informing him of the articular differences between the jaws in the occluded and rest positions; and the path of closure of the mandible to the occluded position will

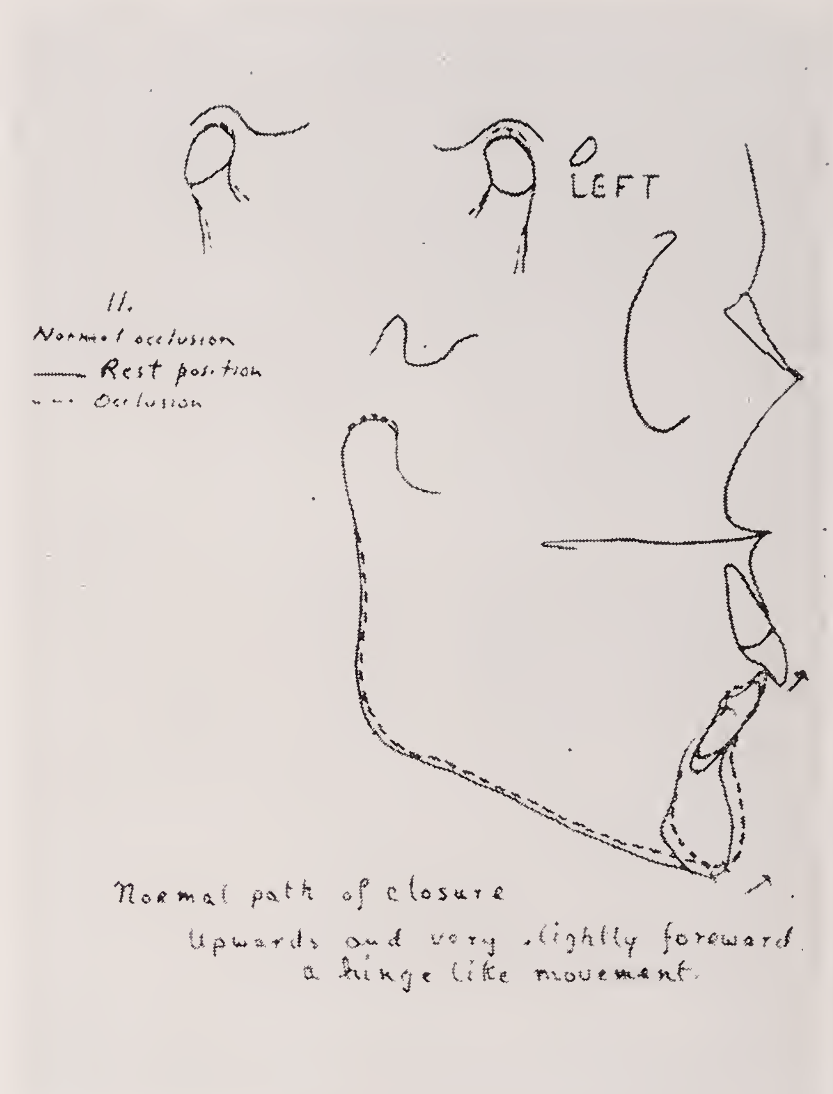


FIGURE 7

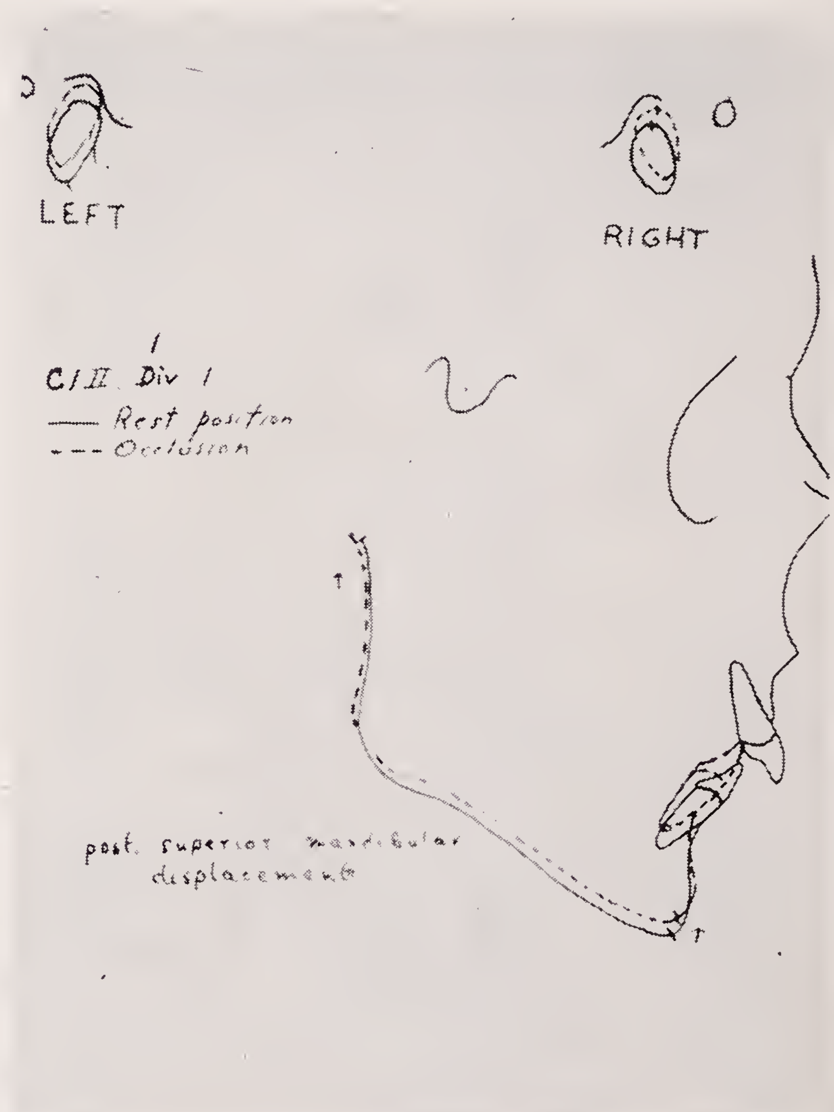


FIGURE 8

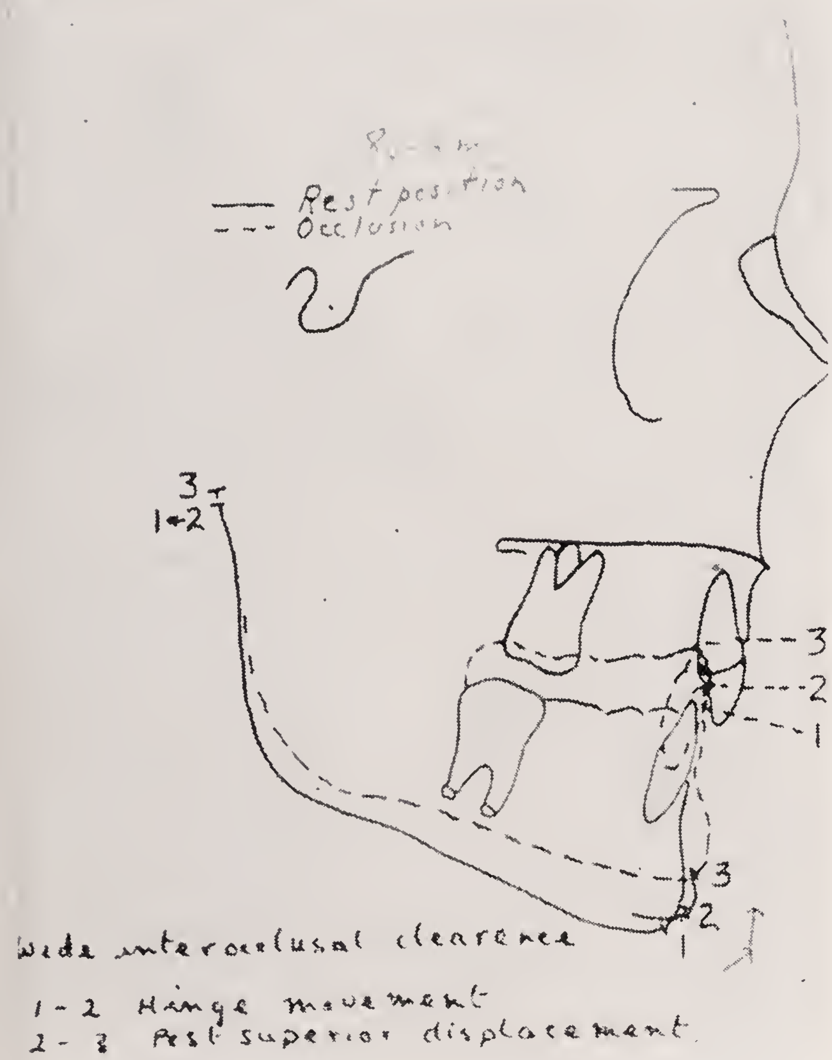


FIGURE 9

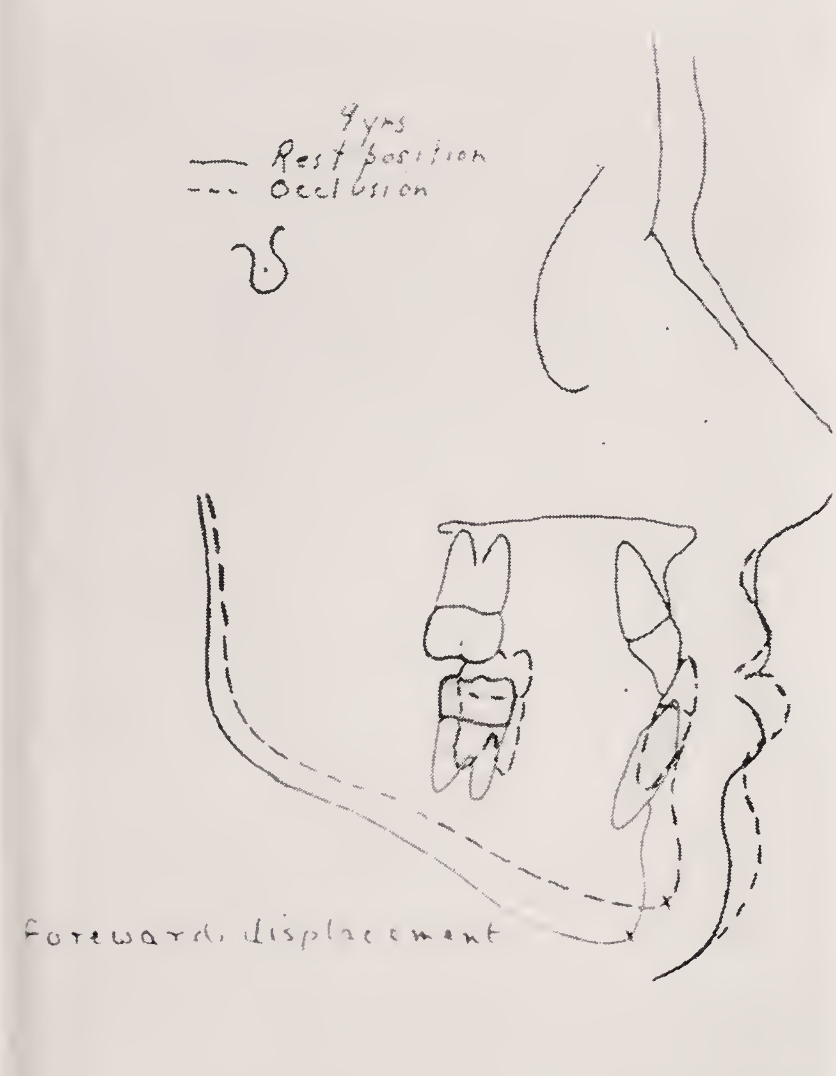


FIGURE 10

indicate the nature of the occlusal interference present, *fig. 10.*

CONCLUSIONS

Cephalometric radiography as a research tool in the study of growth of the head is possibly the best the research worker has at his disposal today.

Conclusions from such work must always be relative, never absolute.

No two points or planes can be considered in absolute terms; they are related to each other only in so far as they are part of the growth pattern of a given child. The method captures moments of growth and, on a serial basis, links them meaningfully in terms of individual growth progress (Krogman).

Serial radiographs show clearly a change in dimension of the skull; the interpretation of the directional nature of this change is dependent upon the particular method of orientation used.

Dimensional changes in the skull occur through biological activity along the lines of the various sutures and also as a result of deposition of bone on the external surface with resorption of the internal aspect. This growth varies in extent in different parts of the cranium, with the result that the skull of the child not only enlarges but changes in shape as it matures. This information has still to be correlated to the composite whole, so that the changes due to biological activity can be explained as they affect the dimensions of the skull in the three planes of space. In many of the standard texts, the reference of the Bolton-Nasion plane is used to demonstrate such changes in terms of biological activity.

The choice of suitable registration points in serial radiography is in many instances very difficult, and disagreement among cephalometric workers exists on this point.

It is realised that no one plane or registration point is sufficient to explain all the details of skull growth. One plane may be used to describe the general

pattern but the validity of choice in the end is bounded by the limitations of our present-day knowledge of biological activity.

The group studies which have been made to study both growth and variation between the associated parts of the skeletal structures have led to the use of statistical analysis as the method of choice in expressing the results of such studies. Lack of appreciation of the true meaning of the terminology involved has resulted in these figures being applied in individual cases as absolute values rather than their being expressive of a range within which a so-called norm can operate for the specific age groups studied.

Cephalometric radiography has been applied in the study of morphological variation expressing the results in quantitative terms. In such studies, even if it were desirable, rigid standards or even a classification of total skeletal patterns, are not possible, since the details of the individual patterns of growth would become submerged within a classification of type. Krogman (1951) has reminded us " that no one dimension, no one angle, no difference of a few millimetres or of a few degrees in an angle, can assume a type difference that is of absolute diagnostic value."

Orthodontic management is limited to very few structures of the dento-facial complex, yet the component parts of this complex are under the influence of factors which show a marked independence both as to mode and timing in their effect. Awareness of this possibility through some method of serial appraisal will help the operator to decide the limitations of any treatment possible within the individual skeletal patterning.

The application of the methods of cephalometric appraisal in analysing the results of treated cases have made it possible to indicate the correlation between intention and accomplishment. Casts alone show only the isolated relationship between the dental arches and the individual dental units. Cephalometric tracings aid in clarifying actual as against visual tooth movements which have been accomplished. Careful study of such appraisals will perhaps indicate the truer possibilities and limitations of the appliance therapies employed.

In conclusion, Higley (1951) has stated: " Treatment methods and philosophies will undoubtedly be further influenced as more information from cephalometric studies is acquired. It is hoped that many who have not used cephalometrics will do so and thus be able personally to evaluate it as an aid to diagnosis and treatment and perhaps through its use further contribute to the advancement of Orthodontics."

ACKNOWLEDGMENT

The author wishes to acknowledge permission to reproduce *Figs. 1—5* with their explanatory texts from "*The Use of the Cephalometer in the Appraisal of Patients*," based on a syllabus developed by Dr. Wendell L. Wylie and used in the Dept. of Orthodontics, director Dr. Alton W. Moore, University of Washington, Seattle.

Figs. 6—10 from material supplied by Dr. John R. Thompson, Professor of Orthodontics, Northwestern University of Chicago.

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DISCUSSION

The PRESIDENT said she thought the Society was very fortunate in having Mr. Eastwood's paper as the first paper on cephalometric analysis to be read before it. The paper was a warning that anyone starting such work needed years of experience and study before he would be able to produce anything worth while in the way of results. It was a comprehensive survey of the work done in the field of cephalometric analysis since 1930, and the investigators, who had been using these methods for many years, were not yet agreed as to their value. Indeed, it was surprising and revealing that the most experienced were the most cautious in drawing conclusions.

It seemed that each of the different techniques might be useful for examining once change in the direction of growth, and she thought that orthodontists should bear that in mind and could learn a considerable amount from it. Some years ago Hellmann had pointed out that growth took place in different directions at different periods and that those periods varied greatly in different individuals. It was interesting to find that inhibitions in growth in one direction could be compensated by additions in growth in another direction. It all seemed to her to be extremely complex, and she thought that all the members should be very grateful to Mr. Eastwood for the valuable information which he had given them and for the stress which he had laid on the need for caution.

MR. J. W. SOFTLEY said he was not quite sure of the grounds on which he had

been asked to open the discussion. It was true that he and his colleagues had had a head positioner for several years, but the mere possession of such an instrument did not make them experts. They had learned enough to realize that there were a great number of snags. They could confirm, for instance, the instability of the point porion, because if they suspended the patient about the ear points they were apt to mark the point high on the tracing. It was quite easy to change the position of this point by varying the elevation of the patient.

They believed they had now solved most of the technical difficulties and were now trying to make some real use of the machine.

When he was a student, anything and everything which was not understood was sent to be X-rayed. The radiologist was prompted to ask, on many occasions, whether the diagnosis was expected to be typed on the back. This habit of sending patients to be X-rayed had spread rapidly to the orthodontic department, and now that a head positioner was available, no student felt safe in expressing an opinion without a cephalometric X-ray. Of course, as the films were so much bigger they expected correspondingly more information typed on the back. Mr. Eastwood had shown that while the cephalometric X-ray contained much information it was certainly not obvious and had to be searched for and extracted with caution.

He had had the opportunity of reading Mr. Eastwood's paper several times and he thought that the author was to be congratulated on the very well balanced view-point which he had taken of the whole subject. He had not said: " Here is the one and only answer to orthodontic diagnosis." He had put cephalometric radiography into its proper place as an aid to understanding one part of the diagnostic problem and as a help in diagnosis and prognosis in some cases.

Everyone would agree with the view that tracings superimposed about anyone plane or point gave the total change with reference to that plane or point and did not indicate the actual change in any one bone. Mr. Eastwood's interesting series of slides illustrated that point very well. The President had called attention to the need for caution in drawing conclusions from tracings and from the values determined from cephalometric studies. A patient did not, of necessity, become abnormal because one angle or one measurement was not the same as in somebody's work. He thought it was important to work on ranges, as Mr. Eastwood had emphasised, recognising the fact that no particular measurement or angle would apply to every case.

Some of the members present might ask what was the value of a head positioner in the practice of orthodontics. Its value as a research instrument was not in question. There was no doubt that in many cases the jaws were so obviously in harmony and the malocclusion caused by movements of the teeth within the harmonious jaws that a cephalometric analysis merely served to confirm the obvious. If, however, help was wanted in diagnosis it was not beyond the capacity of the average practitioner to use cephalometric methods. For diagnostic purposes only the standard of accuracy need not be so high as when they were used for research. Superimposition was not required except for a functional analysis, and even then a modified method might be used to give the path of closure of the mandible.

From the practical point of view, he and his colleagues had found cephalometric radiography to be of the greatest help in post-normal cases. It was not always easy, in those cases, to tell whether the fault lay with the jaws or with the teeth, and cephalometric analysis helped to decide which it was. It, therefore, gave a more accurate case analysis and suggested the method of treatment. It also helped with the prognosis.

He would ask Mr. Eastwood to enlarge a little on the relation between the freeway space and appliances which were worn at night only. He had been interested, in connection with the path of closure of the mandible to see the slide showing a forward guidance of the mandible to produce what was called a false class III. He thought that the whole thing was inclined to get out of perspective because the right way to look at such cases was from the clinical view-point. Clinically, it was quite easy to distinguish cases which were of the false class III type from those in which there was no bite of accommodation. He thought it was nonsense to say that there must be a cephalometric analysis to find out that particular point.

When results had to be evaluated snags increased, because the standard of accuracy needed to be very high indeed, and the difficulty not only of drawing conclusions but even of drawing the tracing had to be experienced to be believed. He thought that research work was outside the scope of the average practitioner.

Summing up the subject, he would say that if cephalometry was expected to make things easy, disappointment would be in store. It could be used by the average practitioner to help in the skeletal aspect of diagnosis, but research required expensive apparatus, a high standard of accuracy and a great deal of experience.

Mr. Eastwood was very fortunate indeed in having been able to spend some years in America, where those interested in the subject had been piling up experience for over twenty years. It was not at all easy to start out on research work on the subject in this country.

Mr. H. L. Leech said that he would like to thank Mr. Eastwood for his interesting paper, which he thought was quite enough to swallow in one evening.

He thought it must be realised that there were limitations to cephalometric analysis. For example, the angles SNA and SNB and of the Y axis to the Frankfort plane depended not only upon the antero-posterior positions of the points A and B and the chin point but also upon the length of NA and NB and the length of Y axis. He had found that those lengths varied quite considerably. Also, it was usual to relate the axis of the upper incisor to the plane. He had noticed that Mr. Eastwood related it to the SN plane, but there again there was a good deal of variation from the angle of the planes SN and the Frankfort plane.

In tracing the lateral skull radiographs, he found difficulty in determining the cephalometric points accurately. He found that if the external auditory meatus was fairly distinct the points A and B were not so and *vice versa*. Had Mr. Eastwood any method of overcoming this difficulty by giving more exposure to points A and B than the auditory meatus by means of any shutter arrangement on the film ?

He would also like to know whether Mr. Eastwood had any method of stabilising the head in the fronto-occipital plane and whether any research had been done on tracings in that plane, such as the lateral width of the maxilla, the mandible, and so on.

He felt that, although cephalometric appraisal had its limitations, those limitations should not prevent orthodontists from recognising the value of cephalometric analysis in the diagnosis and treatment of the patient.

Mr. C. P. Adams said that he would like to congratulate Mr. Eastwood on his extensive and excellent review of the whole subject of cephalometry. There were two aspects of it about which he would like to ask Mr. Eastwood questions.

First, was cephalometry in fact the best and ultimate weapon which orthodontists had for the investigation of malocclusion and perhaps for research ? He asked that question because, while certain sutures in the upper jaw showed in radiographs, a great many of them did not. As there was no doubt that many of the malformations

of the upper jaw were due to defects in differential growth, did Mr. Eastwood think that it would ever be possible to analyse more than the gross external features of the upper jaw ? Until orthodontists could get a little deeper than that, it was difficult to see how they would ever advance their knowledge of the growth of the upper jaw and hence of the malocclusions due to defects of the upper jaw.

The other point to which he wished to refer had already been touched on by Mr. Leech, namely, the question of the examination of the width of the face. In the early days of cephalometry, considerable stress had been laid on the value of antero-posterior radiographs of the skull, and a number of serial radiograph studies had been made, but since that time very little had been said about the angle of taking these photographs and in the current literature there was no reference whatsoever to it. As there was no doubt, as far as he could see, that a great many malformations were due to defects in the lateral growth, was not it a pity that that aspect of examination had been pushed into the background ?

He would be very glad if Mr. Eastwood would give the meeting his views on both those aspects of the subject.

Mr. A. W. Eastwood, in replying to the discussion, said he would like to thank the President for her very kind remarks about his paper. He was very glad that she had laid stress on the need for caution, because that was one of the most important aspects of the interpretation of any work that was done in the field of cephalometric radiography. Unfortunately cephalometric radiography had for some people reduced orthodontics to a series of angles, planes, lines, and so on, as it was so much easier to use a figure. That had been a hindrance to the advancement of cephalometric work, because, as Brodie had pointed out, people had taken the conclusions as being definite and absolute, which they were far from being. Orthodontists who were going to use cephalometric radiography or have anything to do with it must bear that in mind. It was not a short cut to anything at all. As Mr. Softley had pointed out, it was quite the reverse, and that was why orthodontists should approach it with analytical caution.

Much very valuable work in this field had been carried out at many of the Universities on both sides of the Atlantic but it should be evaluated with that in mind. Broadbent himself had stated that the Bolton-Nasion plane is only a hypothesis and one which did not preclude the possibility of another plane being used in later years as more information became available on the biological processes causing skull growth.

If orthodontists used cephalometric analysis they must use it as an aid and not as the end result. It was very important to remember that.

The standard of accuracy achieved by any of the work that had been done though high it was not absolute. It was generally agreed that a 5 per cent. error was acceptable. If one looked at some of the results of the work and found that from one head plate to another an angle had changed say 2 deg., that 2 deg. might be an error in positioning or one of the minor errors that could creep in in the tracing or something of that kind. The Broadbent head positioner, which was a very complicated though highly efficient machine, reduced the mechanical error to the minimum but never got rid of it.

It was very difficult to register the mandibular rest position and there were all sorts of techniques for doing that. One was to get the patient to repeat Mississippi during exposure. Another was to get the patient to swallow, but swallowing was such an instantaneous action that it was necessary to have a very powerful machine to register it; it was out of the scope of the ordinary machine to do that. One could fit up the ordinary dental

X-ray machine by increasing the milliamperage a little, which would step up the penetration. One could then get acceptable head plates in an ordinary surgery, but it was very difficult to register the rest position. One way to establish the path of closure was to trace the head plate out and then take a tracing of the mandible by itself and superimpose that on the tracing of the whole head plate; then place a pin through the approximate centre of the condyle and just rotate the mandible about this point. That would to some extent give an indication of the path of closure. There would be errors in it, but it was the best that could be done without taking two or even three head plates.

With regard to the importance of the rest position, one did not have to establish it and one did not need a head plate to find it, but one thing that the cephalogram had done was to direct the attention of orthodontists to it, and that in itself was a great help to them in their diagnosis.

With regard to those appliances which were worn at night, if one used certain of the removable plates and wanted the activity of the muscles to come in during sleep there was no point in opening the bite to less than the rest position, because then the teeth would not be biting into the activator at all, and as a result no action would be obtained. In certain cases where there was a wide freeway space a bite plate might be more successful than some of the fixed appliances and might be much easier to use. When the abnormally large freeway space was due to the fact that the molars had not erupted sufficiently the bite plate might deal with that with much greater ease than fixed appliances.

With regard to the variation of the angles SNA and SNB it was, of course, a possibility that it may be due to a variant in the cranial plane SN however it had been shown that the cranial planes in the main, were relatively more stable than others in the dentofacial complex and as such, could be used to describe changes in that complex. All that one could do was to accept as far as possible the fact that cranial planes were relatively more stable than other planes outside the cranial base; should the cranial base itself be the area of investigation, then the choice of suitable reference planes would to say the least be a problem. He was afraid that he could not say any more than that, because it would involve a discussion of everything—sutural growth and biological activity in general—and he would not like to go into that field at this stage.

With regard to the difficulty in finding some of the landmarks, anyone who had used the headplate at all would appreciate the difficulty of locating with precision the Bolton point on successive headplates. It was for this reason that some operators preferred to use other cranial planes which were relatively more easy to locate. Certain of the points are anatomic landmarks but as is the case with many things in this world, practice makes perfect or almost so! If difficulty was experienced in finding some of the points, the cause might be that the X-ray itself was not clear enough or that one had not blacked out the radiograph as one traced. One of the easiest ways of finding the points was to black out the tracing completely and to use a piece of black paper with a hole cut in it, about one inch in diameter, and trace an inch at a time. It was amazing how clearly some of the structures came out if one did that, and the soft tissues showed with startling clearness. If the points still could not be seen and one did not even know where they were, another way of finding their position was to use a reducing glass instead of a magnifying glass; that would show up the head plate as a whole more effectively than if it was just looked at on a shadow box.

As to the question of sutural growth, it was possible to find out what happened in the sutures but it was difficult to relate that to the whole, and up to now, because

the subject was such a difficult one, it had not been fully reported, as one could see from the majority of the literature. In the majority of cephalometric reports the word " biology " very seldom appeared, that was a serious lapse, because without biology there would be no head plates. Broadbent in 1937 propounded his Bolton-nasion plane and he showed the directional pattern of growth, but the Bolton-nasion plane should not be accepted simply because it answered a good many very difficult questions. When orthodontists read or thought about this work they should question it at the same time, because for the advancement of knowledge it was not only positive knowledge that was needed; negative knowledge was just as important. Revision was as valuable as the writing of something new, because in going through the literature one might be able to correct some misunderstandings and misapprehensions. He himself had perused the cephalometric literature over a period of about twenty years, and the contradictions that one found from one year to the next, usually over a period of five years, were such that in some instances one did not know whether one was coming or going. It was generally accepted that the face grew downwards and forwards, but the first question that arose was why it should do that. How did one know that the Bolton plane was what it appeared to be? Broadbent had said that it was the best one that he could find, and that was all one could say about any plane, in view of the limitations of the present knowledge on the subject. One could not say any more, and if one tried to do so one would not be scientific about it.

As far as was known, the cephalogram showed the total growth changes. Broadbent had related the antero-posterior and the lateral head plates, the antero-posterior head plate showed certain things quite well, but unfortunately a great deal of work had not been done on it, probably because it was very difficult. Too much emphasis had been placed on the lateral head plate, probably because it was so much easier to use and work with, thus the antero-posterior head plate seemed to have disappeared into the background. It had, however, been used by Broadbent and others. In this connection he would suggest that orthodontists should go over some of the literature and evaluate it for themselves.

With regard to studying the growth of the skull in detail, he thought that, when there had been more experience in its use, the laminograph might provide many of the answers; however this machine when used produced a series of lateral or frontal headplates taken at different levels through the skull and the same problem still remained that of relating this information to the composite whole in the three planes of space. Mr. Anderson had told him that though the laminograph in use at the Orthodontic Department of Glasgow University was providing much very useful information, they were still faced with the same problem of how to relate it to the skull as a whole.

In conclusion, he would like to say that he hoped no one would leave the meeting with the feeling that cephalometric radiography would give them all the answers. In order to get the most out of it, orthodontists must use it themselves. They could be told a great deal about it and shown what planes and angles had been suggested. Orthodontists should evaluate them for themselves, having in mind all the current information available about the associated signs in connection with the growth of the skull.

On the motion of the President, a vote of thanks was accorded to Mr. Leighton and Mr. Eastwood, and the meeting then terminated.

A Classification of Post-Normal Occlusions

R. B. Dockrell m.a., m.b., b.ch., b.dent. sc.

Since Angle first divided all malocclusions into three classes on the basis of the sagittal arch relationship, many people have pointed out the unsuitability of a classification on this basis. All malocclusions are signs or symptoms, not causes, and are therefore theoretically unsuitable as principles of division. To classify according to them is analogous to classifying ailments of the rest of the body on a basis of " pain " or " enlargement." However, just as it is sometimes useful to find out the type of pain in order to push one's diagnosis further so orthodontists have found it useful to accept the three Angle classes. The justification seems to lie in their extreme simplicity and in the fact that they are an admirable basis for treatment. This paper, therefore, accepts the Angle principle of division and attempts from there further to subdivide the class II in an effort to adapt it to the newer and wider techniques of diagnosis.

Although Angle himself, by subdividing the class II malocclusions, recognised the need for breaking it up into smaller groups, yet the principle he adopted, that of maxillary incisor inclination, has been widely questioned. The further efforts to break up the class II malocclusions have, in each case, come from an effort to correlate the dental arch and the jaw relationship, and both with the rest of the skull. The acceptance by orthodontists of the anthropological view that deviations of the upper jaw occurred in class II cases meant that one could superimpose an idea of the jaw affected, either maxilla or mandible, on to the Angle classification and thus double the number of categories. Simon's classification in this respect was an effort to correlate the position of the arches to the rest of the skull and its failure sprang, not from disagreement with the principle, but from the ineffectiveness of the orbitale as a fixed point. Lundstrom's[2] recognition of the independence of the alveolar process and the apical base as regards size was an important step towards dividing up the class II in that it eventually involved anteroposterior deviations also. Once the independence of the two parts is recognised as regards size an idea of their independence as regards position must follow since in many cases it is mere hair-splitting to attempt to decide whether a given upper base is " subnormal " anteroposteriorly or " postnormal."

The use of lateral X-ray tracings was another great step in the investigation of facial and cranial relations. So far these tracings have been used in two respects; analytically to investigate normal and abnormal cases (Björk, Broadbent, Brodie, Downs, Higley, Marjolis, Thompson and Wylie, to name only a few) and synthetically as a means of classification. The latter classify according to various angles (facial angle, Frankfort-Mandibular plane angle, etc.) or on a metrical basis (Wylie, 6). To this group belong the skeletal classifications which seek to differentiate anteroposterior basal deviations from purely alveolar ones. I have no knowledge of these lateral X-ray techniques and methods but I understand that some of the points are difficult to define and even after

Paper presented to the meeting on 10th December.

that there would appear to be room for considerable error since, in a paper published this year, Ballard[1] quotes the SNA and SNB angles as having been worked out to two places of decimals and yet one of his tracings gives an error of 6° in four other angles measured. It would appear, therefore, that the method, though by far the best available, should not be pressed too far at present. It would also seem to be advisable that workers using this method should work out in detail their errors in location and measurement before drawing conclusions from minor changes.

There has, however, been surprisingly little attempt to synthesize from the analytical investigations and there still does not seem to be any simple grouping of categories which may be used clinically apart from a division into whether the maxilla or the mandible is primarily concerned and whether the alveolus alone, or the alveolus and base together, are displaced relative to the rest of the skull.

But none of these subdivisions appears quite adequate. Every clinical orthodontist finds that there appear to be a number of different types in the Angle class II and that each type is associated with definite syndromes or groups of symptoms. The types vary according to the population one is working with but when one begins to think of one's patients certain clinical groups come to life and these do not appear to be adequately covered by the existing subdivisions.

In attempting to approach this problem there are several ways in which one can proceed. One may classify according to the accompanying signs and symptoms, as Angle did, but this process is apt to prove cumbersome when pushed on to the point where it does become adequate. One may, ideally, classify according to the aetiology, a principle which is apt to break down since the aetiology of malocclusion is, at present, a science of lost causes or at least a field for speculation. Finally, one may classify according to the site attacked by the causative agent and, since all discrepancies of sagittal arch relationship must entail a bony deviation or deviations from what we consider harmonious for the individual, that is the principle which will be followed here. In another communication, I have stated that I believe all causes of malocclusion may be more easily and logically considered under the heading of the tissue or site primarily concerned and that I believe every cause must sooner or later affect one of five sites. These latter sites will affect one another secondarily and the presenting signs and symptoms are the result. This paper, therefore, is an attempt to examine the field of class II malocclusions and accepts the fact that the cause may not have affected bone primarily at all; some of these changes will be due to a cause which has directly attacked the bone itself, some will be secondary changes, the result of causes operating in other tissues. In addition, instead of starting from patients and working backwards, it is more convenient to begin by examining the theoretical ways in which any cause could effect a postnormal occlusion, from there to work out what accompanying signs and symptoms ought to be present, and then finally to see if these theoretical categories will fit actual patients.

For reasons that will be apparent later it is only possible to assume one change at a time. Therefore to illustrate most of the possibilities involved a number of diagrams has been prepared. They have all been made from one single tracing of a male aged 27 with normal occlusion. In all, the normal tracing is on the left-hand side, and then, in the centre, a tracing with one part in an abnormal position is superimposed on the dotted outline of the normal. On the right-hand side this tracing, containing an abnormality in some part, is fitted to a normal maxilla or mandible, as the case may be, in order to yield a class II malocclusion. *Figures* 2 and 10 have been exaggerated in the right-hand construction

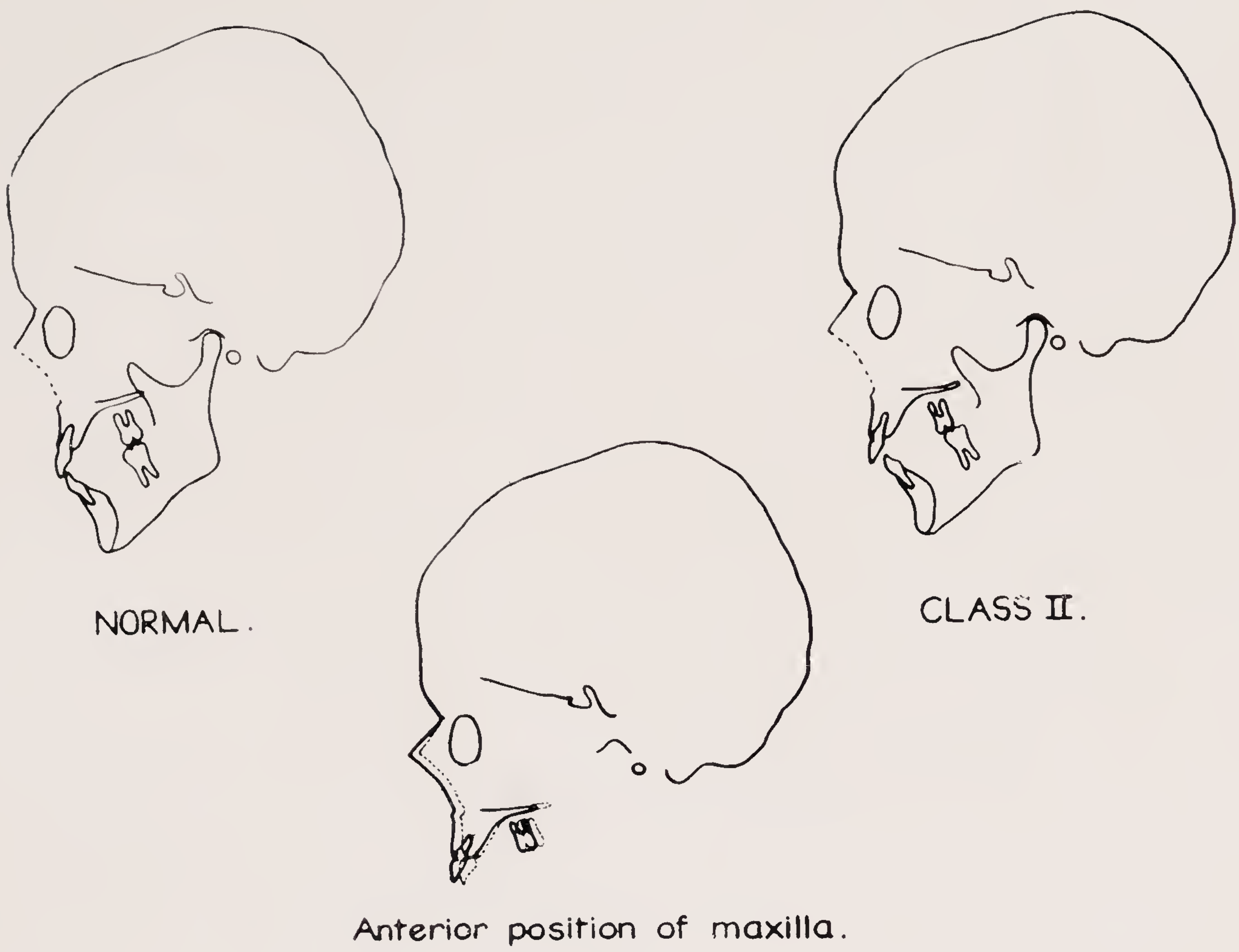


FIG. 1

in order to show a full cusp unit of class II malocclusion. In addition, the term " class II " is used where possible in preference to " postnormal " or " distal " occlusion as the latter become quite misleading when applied to what is obviously a maxillary " prenormal," or " mesioclusion." Also, when the terms " displacement," " increased growth " or " diminished growth " are used they must be understood to be relative to the rest of the cranium and not in an absolute sense.

To start with the maxilla, one may say that a relative overgrowth in the upper part of the cranial base including the sphenoidal side of the spheno-maxillary suture could displace a maxilla, completely normal in every way, into an anterior position in relation to the mandible and give rise to a class II malocclusion (*Fig.* 1). Because, too, the temporomandibular joint is in part a hinge joint, any cause which displaces the whole maxilla downwards will force the horizontal ramus of the mandible, including the lower teeth, backwards as well as downwards and so a downwards displacement of the maxilla by the frontal bone could cause a class II case (*Fig.* 2). *According to my models, only a very severe displacement downwards of the maxilla*, such as never occurs in ordinary practice, could yield a full class II malocclusion but undoubtedly less severe degrees predispose towards the development of the condition and so we must list downward displacement of the maxilla as a predisposing cause. For clarity, the diagram shown here has been drawn to show a full cusp-unit of postnormality and is, therefore, exaggerated.

In the same way, an actual overgrowth forwards of the maxilla, relative to the mandible, could cause a full class II case and an overgrowth downwards a minor degree, but in these cases the maxilla will be larger than in the displacement cases. It is well here to note the differing effects of growth at the different sites of the spheno-maxillary and fronto-maxillary sutures. Growth on the cranial side displaces a normal maxilla, growth on the maxillary side or at a free border of the maxilla yields a larger maxilla. In view of

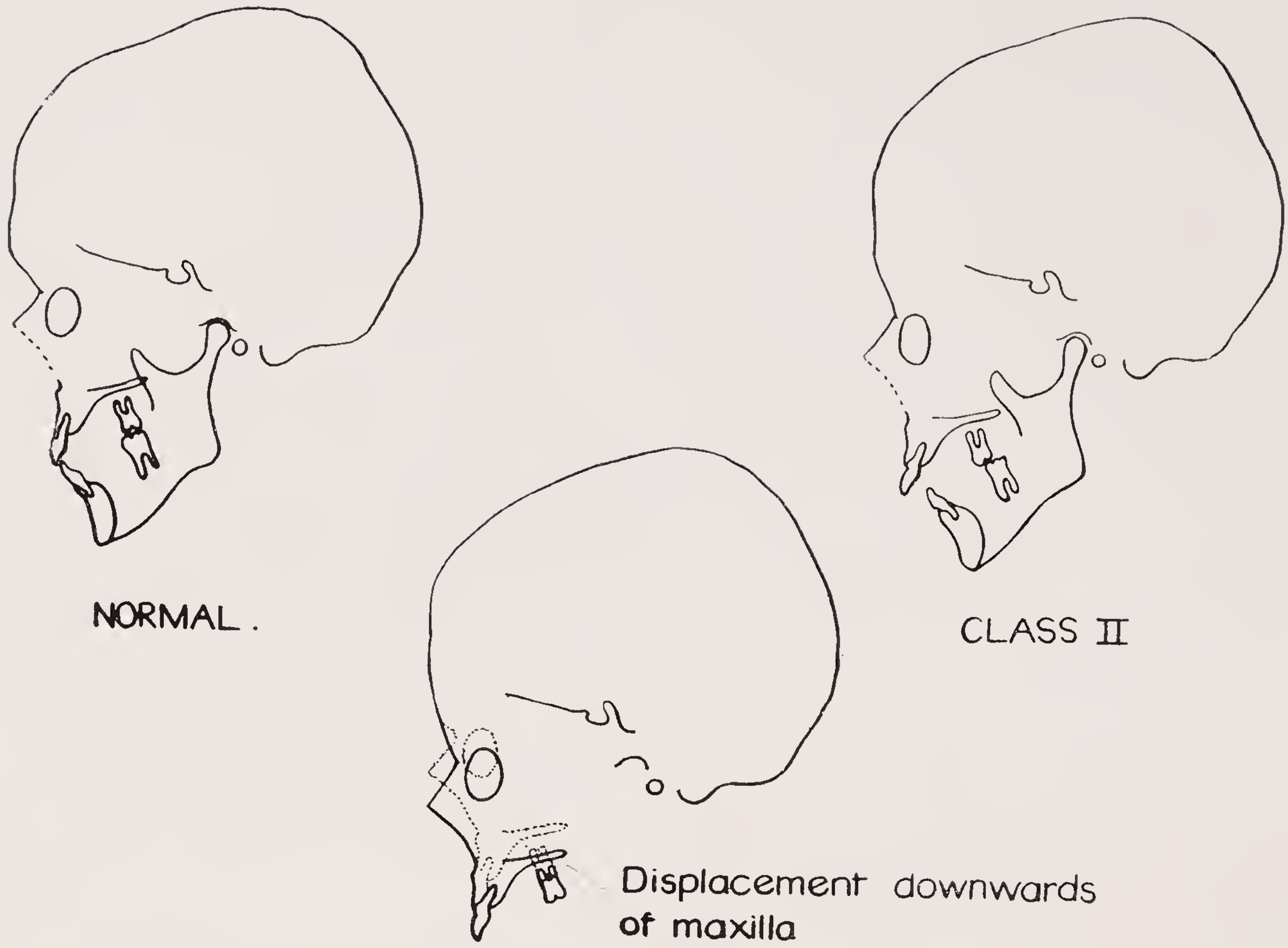
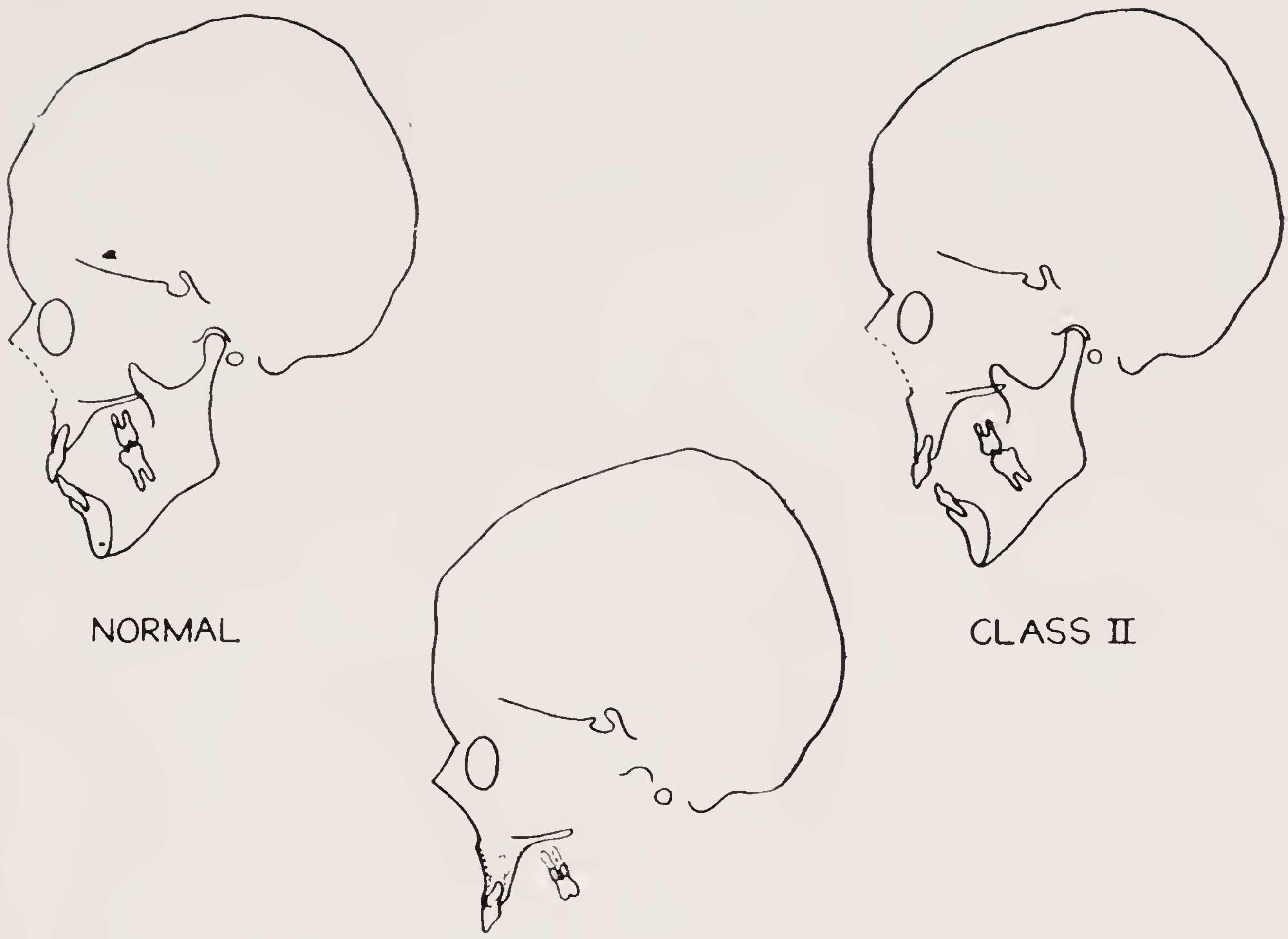


FIG 2.

the high degree of independent variation of the cranial bones it seems quite possible that, not only is growth proceeding at different rates in different sutures, but also on different sides of the same suture.

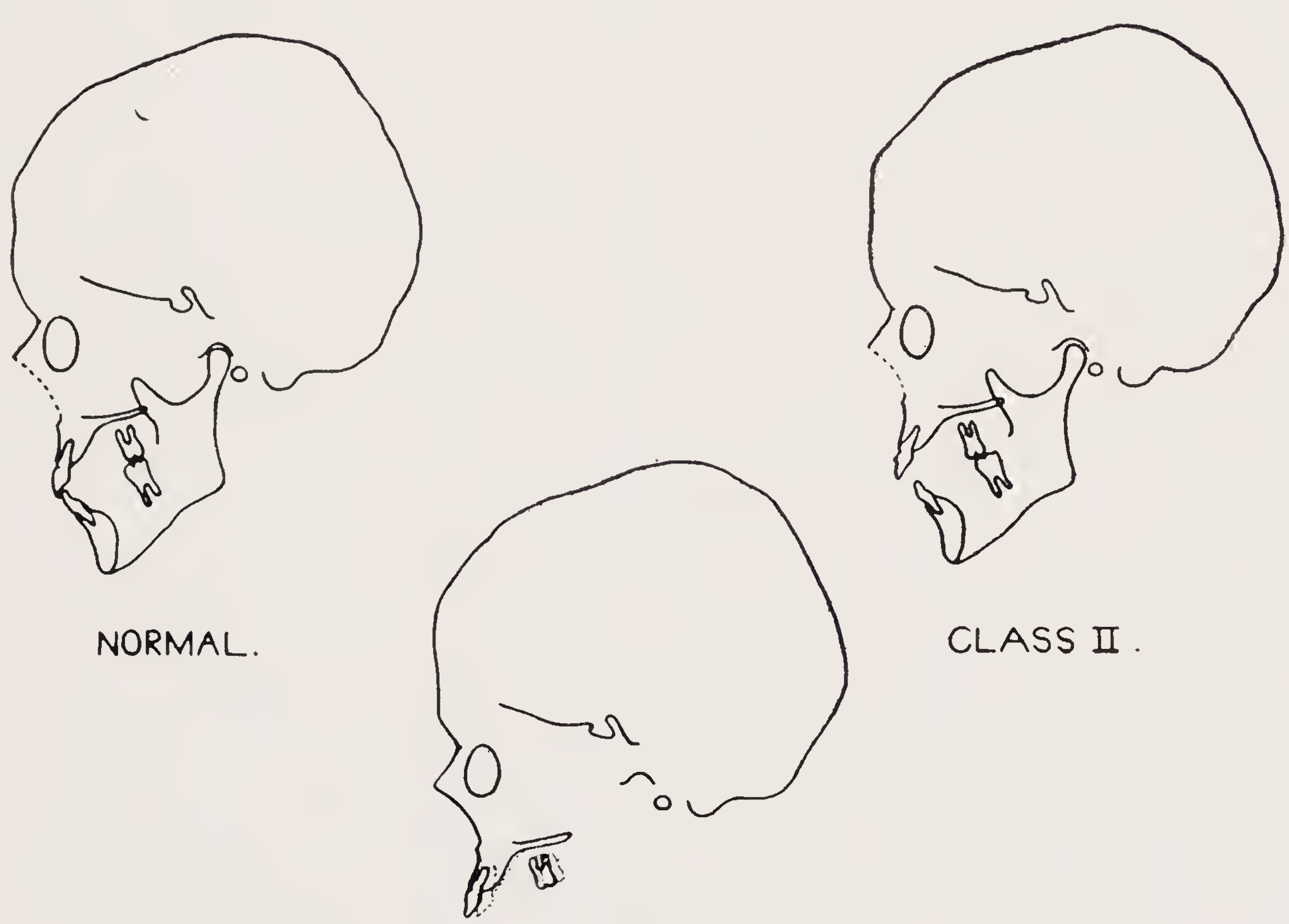
While still dealing with the whole maxilla, it is wise to accept the possibility of abnormal growth rates in the three dimensions or of changes in growth direction, all of which manifest themselves in an altered shape of the bone. We must, therefore, consider not only relative overgrowth of the maxilla in all directions but also list separately overgrowth anteroposteriorly, overgrowth downwards (*Fig.* 3) and diminished lateral growth. The latter might force the patient gradually to accommodate himself into a class II occlusal relationship. As it might equally well force him into a class III position with a molar crossbite, it cannot be regarded as a constant feature and so it has been bracketed in table I.

The changes so far considered are only those affecting the whole maxilla but there seems to be plenty of evidence that the alveolar process and the teeth could be affected without the rest of the maxilla. They, too, might be displaced forwards (*Fig.* 4) by a relatively greater growth of the lower part of the cranium with a forward tilting of the maxilla round its upper part, but they cannot be displaced downwards without the rest of the maxilla. They could also grow forwards to a greater degree than the rest of the maxilla but, by definition of the alveolar process as the bone which encloses the roots of the teeth, as it grows downwards it carries the teeth with it and becomes successively converted into maxillary base. Therefore, it is impossible to distinguish between maxillary basal overgrowth craniocaudally and alveolar overgrowth. The term " alveolar " is a clinical convenience but it does involve one in troubles when analysing changes and I have found it more convenient to lump it together with the teeth and to regard both of them as acting as a unit. Since we never see the upper teeth denuded of bone I have not postulated an anterior position of the teeth in a normally placed alveolus and similarly for so long as we define alveolar bone in the



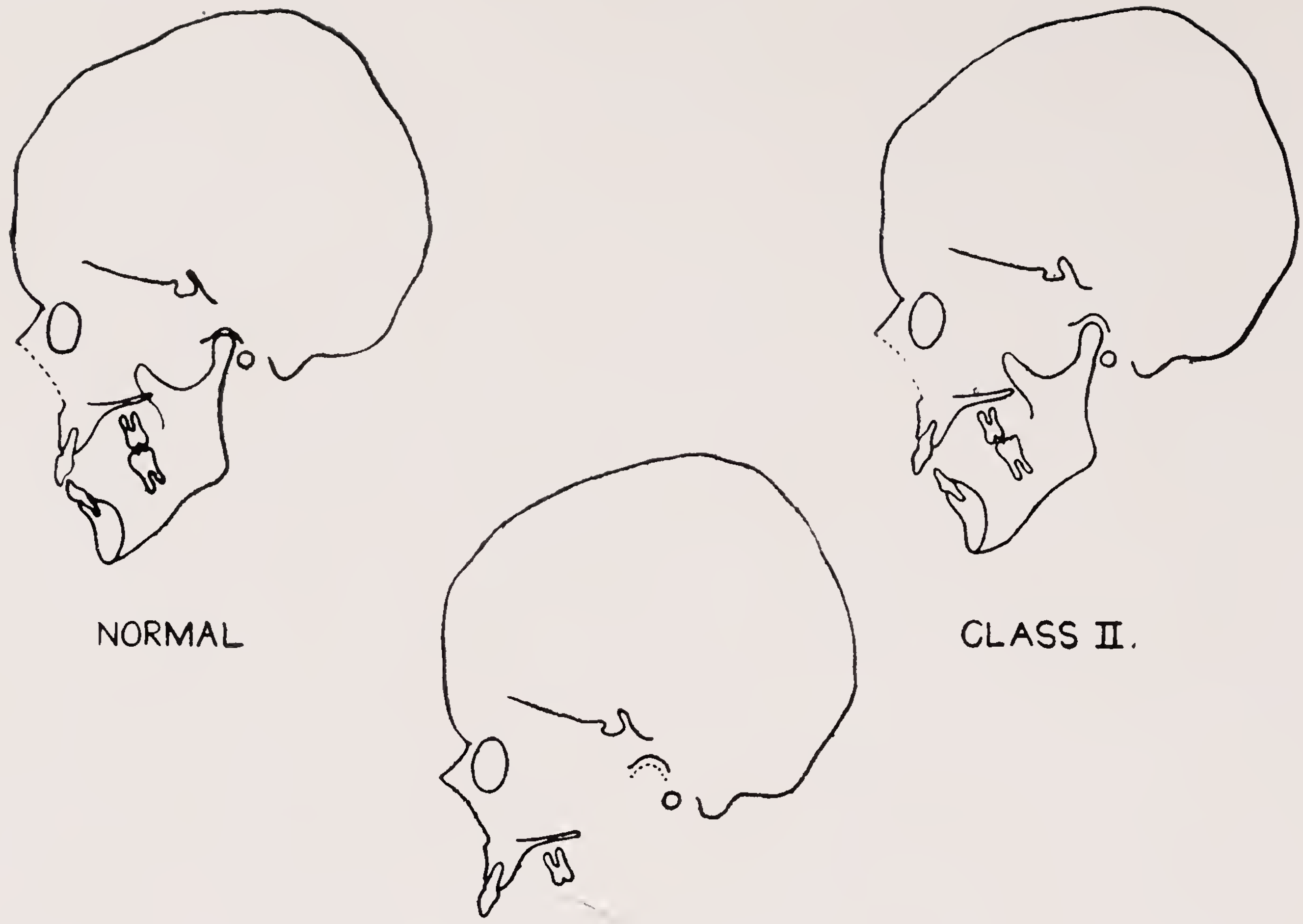
Increased vertical growth of upper teeth

FIG. 3



Anterior position of alveolar process.

FIG. 4



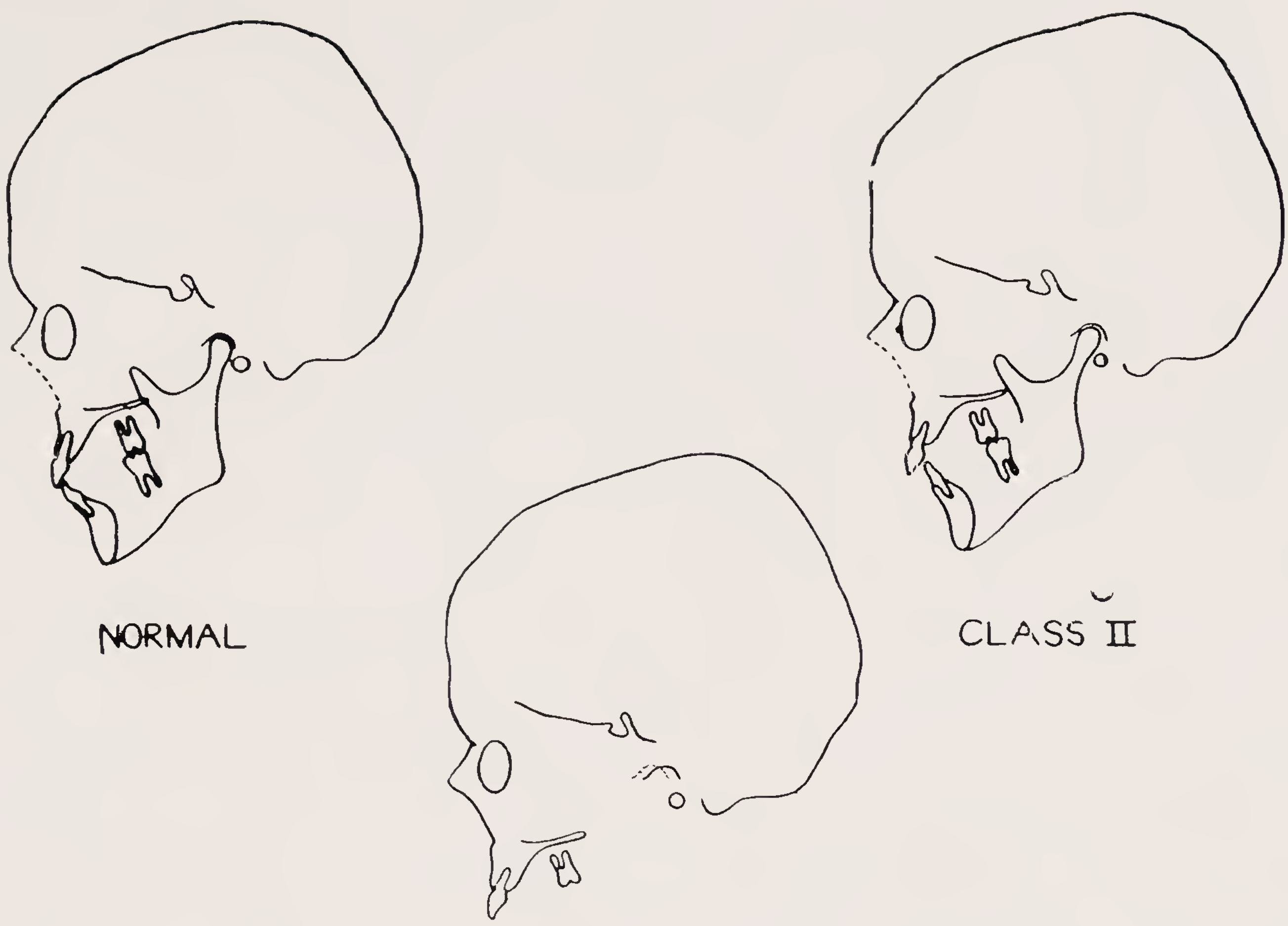
Displacement upwards of glenoid fossa.

FIG. 5

way we do we cannot easily distinguish its vertical growth from that of the rest of the bone. For the alveolus, therefore, we must postulate growth changes in two directions — overgrowth anteroposteriorly and diminished lateral growth.

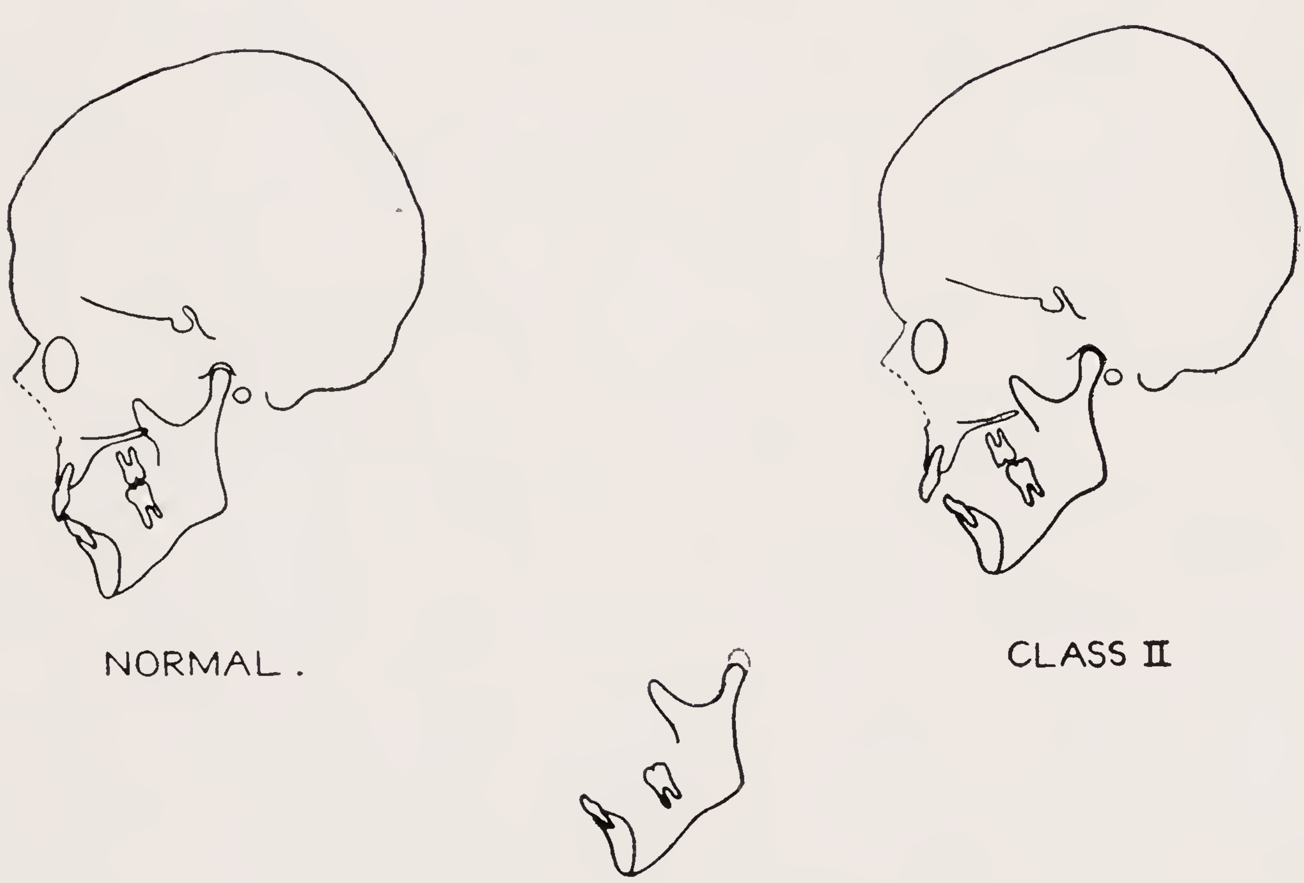
When the causes operating through the lower jaw are considered, we must postulate a displacement of glenoid fossa either upwards (*Fig.* 5) or backwards (*Fig.* 6) relative to the maxilla which would keep a normal mandible in a class II relation. Decreased growth of the mandibular condyle either backwards or upwards will present in the same way (*Fig.* 7). There is another possibility at this site. If the condyle change its growth direction and grow at its anterior or anterosuperior aspect instead of its posterosuperior aspect, the eventual result would be a decrease in the angle between the horizontal and the ascending rami and this would carry the horizontal ramus into, or hold it in, a more posterior position relative to the maxilla (*Fig.* 8). This possibility has another interest in that it is the only one in which a close bite occurs primarily. As the angle between the rami decreases the lower incisors are carried upwards as well as backwards. According to my rough measurements, a change of about 15° in the angle of the mandible will cause a class II malocclusion without any other factor.

In the same way, the horizontal process of the mandible might be primarily displaced backwards or it could develop in a posterior position relative to the condyle (*Fig.* 9). It could also fail to grow at a normal rate. For it, as with the maxilla, the different directions of growth must be separated. It is, however, important to note that growth upwards tends to displace the horizontal ramus downwards and backwards relative to the maxilla but that this tilts the mandibular occlusal plane and throws the direction of eruption of the lower molars much more anteriorly. (*Fig.* 10). Therefore, overgrowth of the mandibular alveolar process upwards can only have a very minor tendency towards the development of a class II relationship. This diagram, like the similar maxillary one, has been exaggerated.



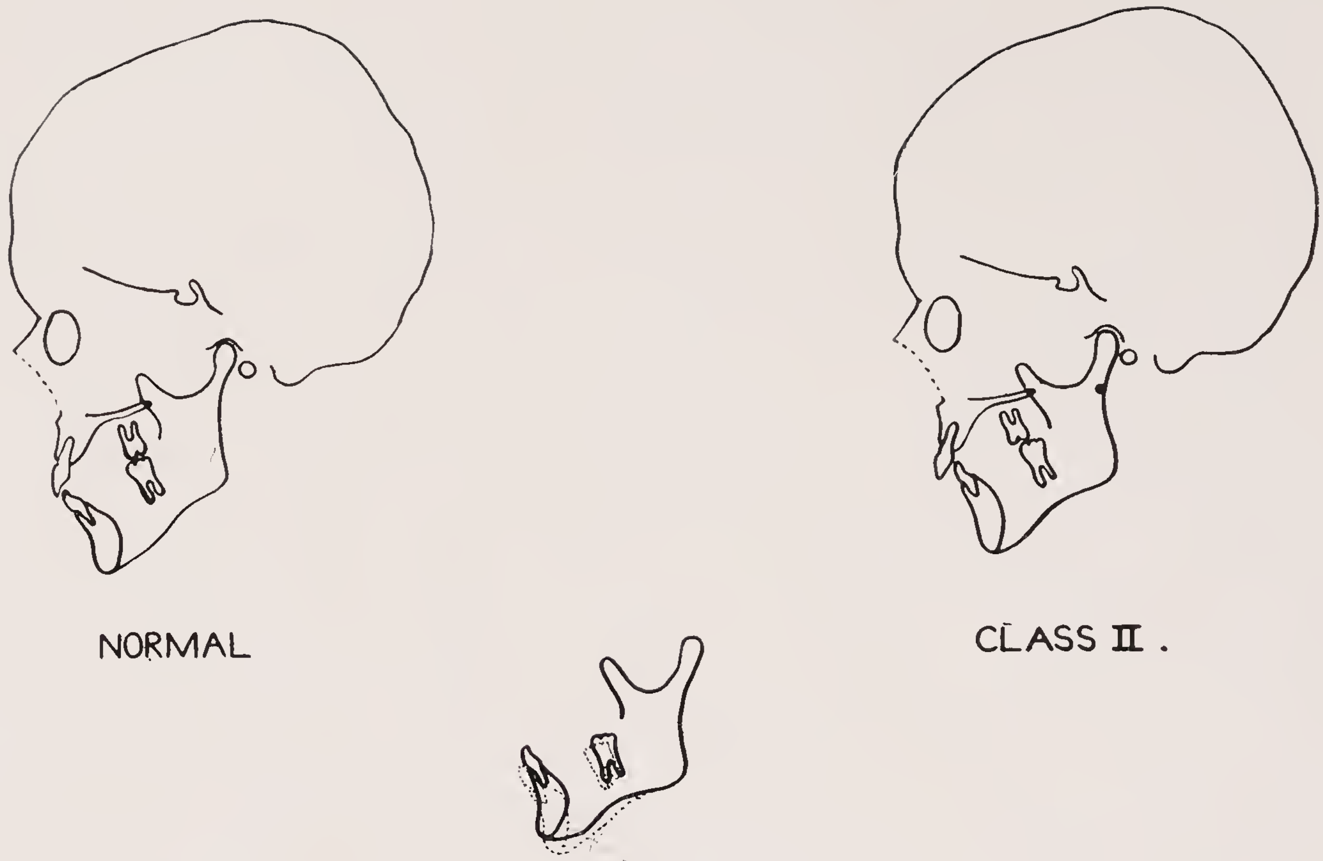
Displacement backwards of glenoid fossa

FIG. 6



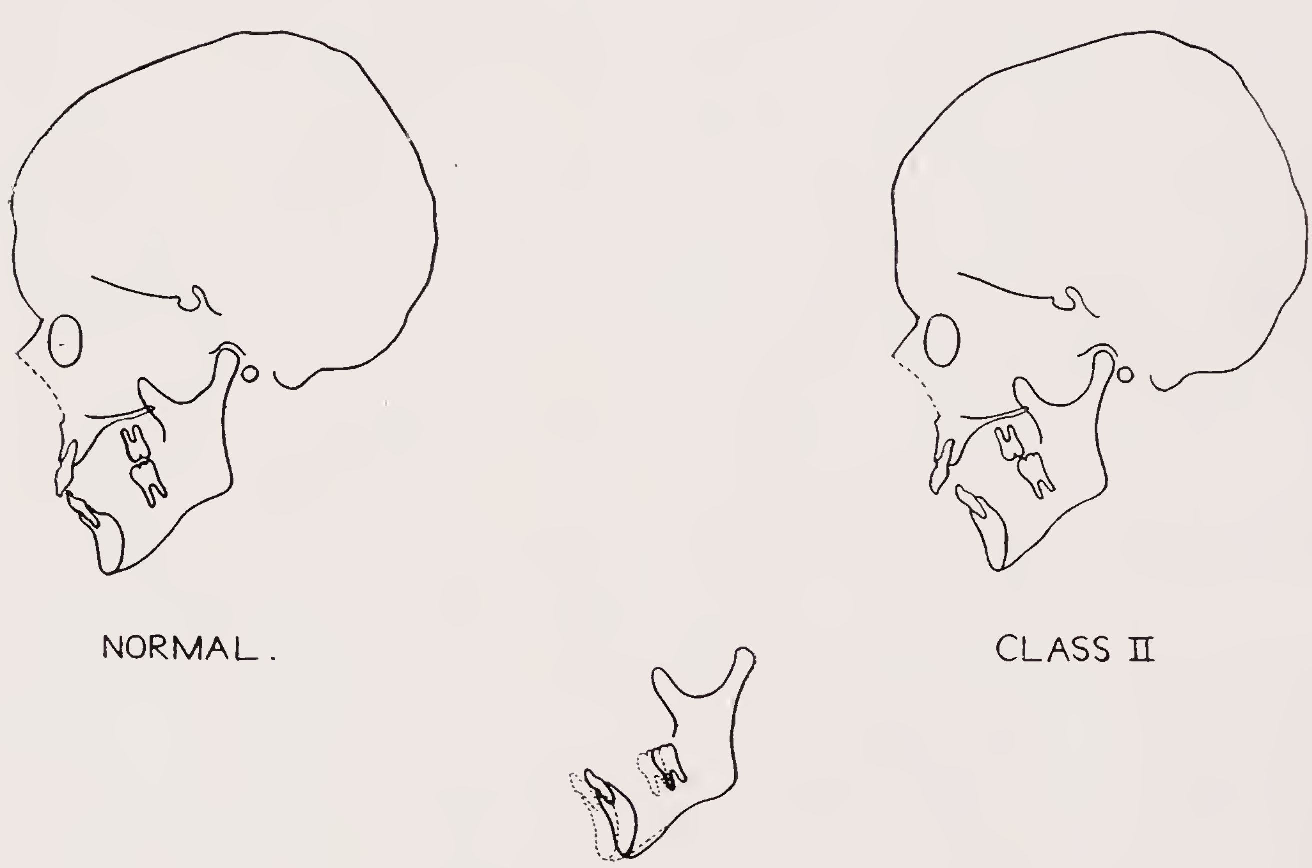
Decreased condylar growth.

FIG. 7



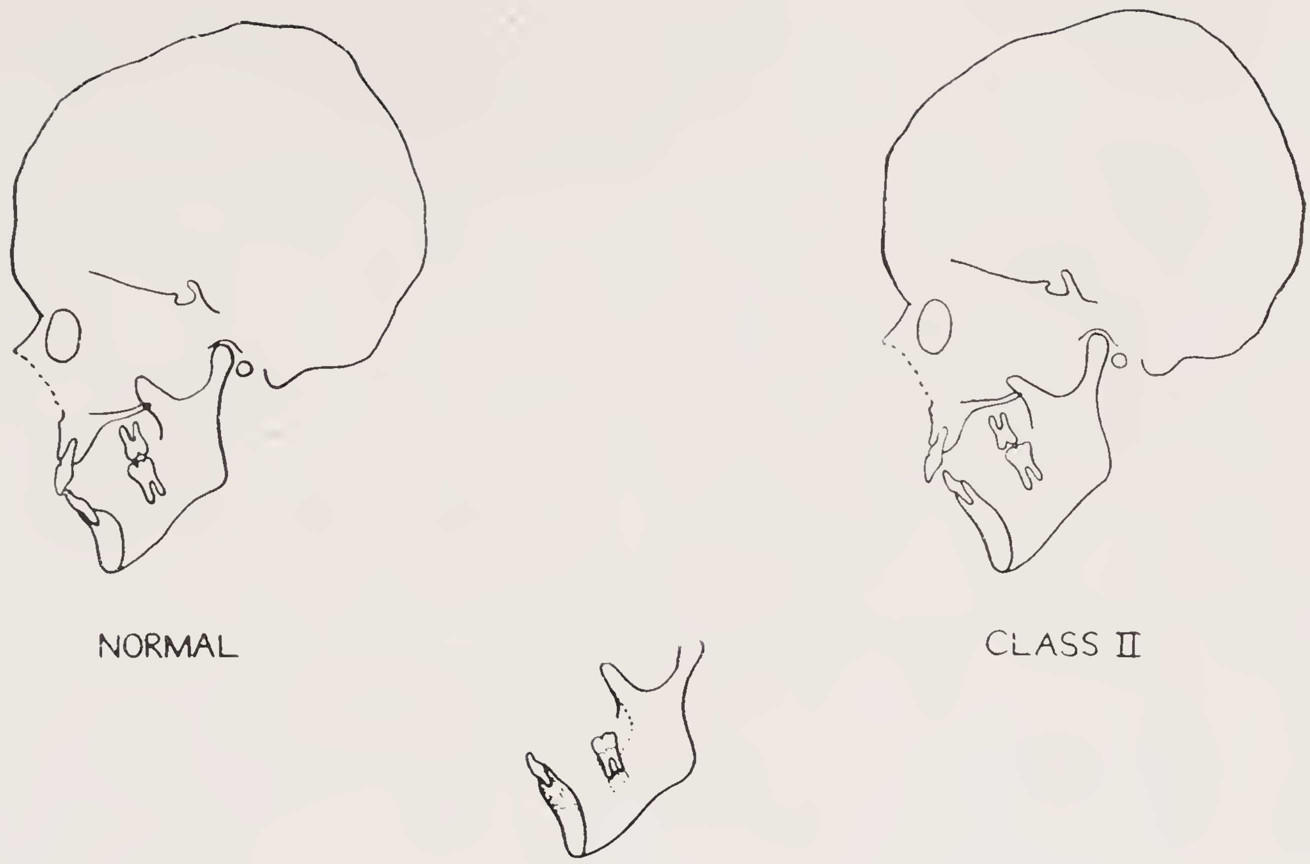
Decreased angle between horizontal and ascending rami .

FIG. 8



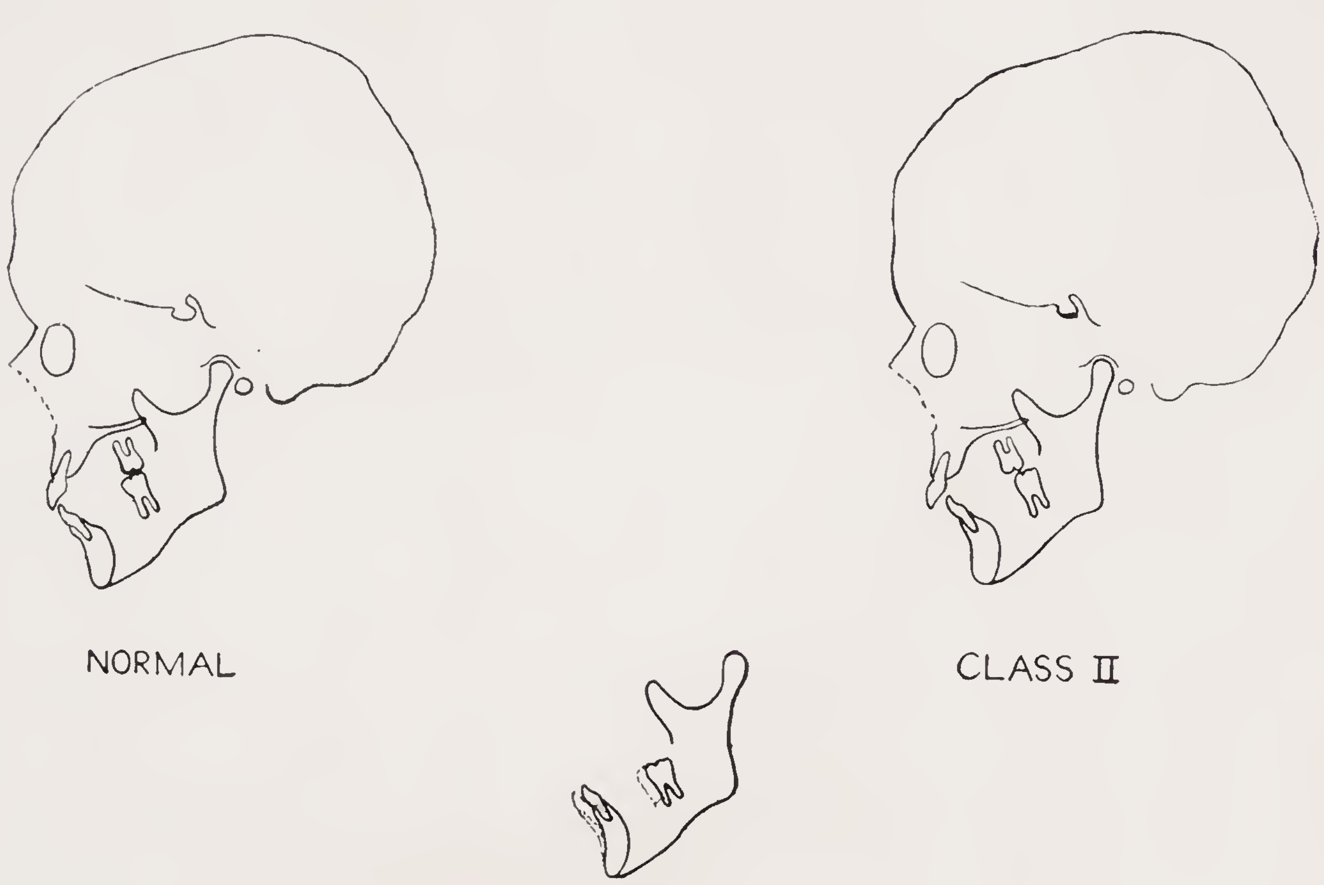
Shortened horizontal ramus.

FIG. 9



Increased vertical growth of lower teeth

FIG. 10



Shortened alveolar process.

FIG. 11

It is also possible that the mandibular alveolar process and teeth might be deflected backwards in relation to the rest of the mandible or that they might fail to grow forwards (*Fig.* 11).

There is one other factor that ought to be mentioned here. Thompson[5] has found out that some cases of class II malocclusion were not in a class II relationship when in the " rest " position. This raises an important issue. We have accepted that the mandibular condyle can normally be moved only one millimeter distal from its occlusal position and the question immediately arises as to whether the " rest " position of these patients with class II occlusion is with the condyle anterior to its " occlusal " position, which Thompson's investigations do not suggest, or whether the effort to overcome an abnormal occlusion has gradually led to a change in the glenoid fossa and/or condyle with an increase in the mobility of the joint, between those two positions. The latter would appear to be the correct explanation as Moyer's investigations into the electromyography of the muscles in temporomandibular movement show[4] that the closure pattern may be altered by occlusal factors and suggest[3] that some Angle class II division 1 malocclusions may have arisen in this way. Despite these important contributions, there seems to be much room for further investigation in this field, however, as there are still a number of conflicting views about muscle tone, posture, and rest position. If we have a constant rest position we cannot have a constant muscle tone, and vice versa.

From the foregoing theoretical possibilities, two tables may be drawn up. The first (*Table* 1) shows what ought to be the chief diagnostic feature in each category together with the site affected, the part of the jaw that will appear to be affected, the agency, and the way in which it arose. There is one very important point to notice here—the evaluation of a " large " or of a " small " part should not be made on a basis of the tooth size. That depends on other factors and a discrepancy between tooth and bone size does not justify the diagnosis of a small or of a large jaw e.g. one could have an abnormally large maxilla with crowding if the teeth were exceptionally large.

The second (*Table* 2) lists the factors which tend to produce a class II malocclusion, listed under the various headings and opposed by the factors which tend to prevent the production of this type of malocclusion. A class II malocclusion can now be seen in its true light as the result of a lack of balance between these two columns with the left hand one in preponderance and every single case we see is in either balance or imbalance in respect of these factors.

The division which has occurred up to this, where only one factor has been considered at a time, is artificial but the necessity for doing so can be realised when it is appreciated that the total number of combinations of these factors run to over 500,000 leaving out the bracketed factors and without even allowing for the existence of a mean or of a unilateral condition. Although it would be impossible for all of them to present as class II malocclusions yet at least one half of them could. The basic unsuitability of a classification on this symptom can, therefore, be easily shown.

However, as many orthodontists do use some classification depending on sagittal relationship it has appeared worth while to simplify from (*Table* 1). In practice one does find that usually one factor does predominate and that the others may be disregarded for classifying. Also the agencies of " shape," with the exception of the condylar one, may be disregarded. It is enough to remember that " size " need not manifest itself equally in all directions. Another table (*Table* 3) can therefore be drawn up showing the recognisable clinical classes. The maxillary classes can now be seen to be whether the

FIG. 12

whole maxilla and teeth, or only the alveolar process and teeth, are in an anterior position and the agency through which they are there. This must be due to either a factor behind and above the maxilla, or a growth change in the maxilla itself. The mandibular group is a little larger and in this case it has appeared worth while to list the whole mandible as well as its separate points of condyle, horizontal ramus, or alveolus and teeth. In these classes the same agencies are plotted. The site " condyle " still has the agency of " shape " included as it appears that the

FIG. 13

angle between the horizontal and ascending rami may be a factor in class II malocclusions. The glenoid and condylar causes can only be diagnosed by X-ray and as I have not got an X-ray machine and craniostat, I cannot use them for diagnosis. Where there is a condylar or a glenoid cause operating they present as clinically similar cases and I am forced to place them both into the same category (whole mandible " position "). The extent to which the various categories can be used depends on the extent of the available equipment and the views of the user. I have already

FIG. 14

referred to the fact that radiologically one could separate condylar changes from glenoid changes. Again, the user's views on the question of bony resorption at the anterior border of the ascending ramus will condition the use of the mandibular group. If one believes that resorption does take place there, then diminished condylar growth could cause a shortening of the horizontal ramus anteroposteriorly, and a case with a shortened horizontal process could have arisen from a condylar change. If one does not believe that resorption does take place there, then a shortened

FIG. 15

horizontal process could only have been caused by a cause affecting that process and, if it is associated with a condylar defect as it often appears to be, then one must postulate that two sites have been affected. Therefore, for this classification, defects of the whole mandible have been listed separately from defects of the condyle or defects of the horizontal ramus.

It also seems desirable to extend the classification to take in co-existing variations in tooth-bone size. An easy way to chart a discrepancy is to use the sign " = " where there is no discrepancy, " + " where

there is a discrepancy with bone larger than is necessary to accommodate the teeth and "—" where the bone is too small to accommodate the teeth. A horizontal line can be drawn and the appropriate sign for the upper jaw placed above that for the lower jaw. Each of these possibilities is charted against the type and agency of the case. It has been mentioned before that it is not desirable to decide the site of the abnormality by comparison of the bone size with that of the teeth but at this point a very useful check upon the previous diagnosis may sometimes be obtained. If, for example, there is not any discrepancy between the bone size in the upper jaw and there is insufficient room for teeth in the lower ($\frac{=}{-}$) it suggests an abnormality of " size " in the lower jaw whereas spacing in the upper jaw, combined with no discrepancy in the lower ($\frac{+}{=}$), suggests a maxillary " size " condition.

In conclusion, I would like to show some photographs to illustrate points that have arisen. The first (*Fig.* 12) shows the profile views of a patient with a class II malocclusion. In the upper photographs she is shown with her jaws in the occlusal position and in the lower ones her teeth have been separated to just beyond the rest position. The lower photographs show the way her chin has moved downwards and backwards. In this type of case, the short lower face height is lessening the degree of class II malocclusion and any effort to treat it by encouraging molar eruption will increase the degree of class II malocclusion.

The remaining figures show some examples of the working of the mandibular part of the classification. The first (*Fig.* 13) shows what I classify as a whole mandible " position " $\frac{-}{=}$ case. The next (*Fig.* 14) shows a whole mandible " size " $\frac{-}{-}$ case and the last (*Fig.* 15), a thumbsucking case shows a mandibular alveolar process and teeth " size " $\frac{-}{-}$ condition. These thumbsucking cases usually show tendencies towards the whole mandible " position," the mandibular alveolus and teeth " size," and the maxillary alveolus and teeth " size " classes but it is usually possible to decide what change predominates.

I would also like to record my indebtedness to Mr. J. W. Softley who obtained the tracing from which all these diagrams have been constructed, and also to Professor Friel for his advice and help.

DISCUSSION

The President, in thanking Dr. Dockrell for his most interesting Lecture, foresaw for herself, at any rate, an increased interest in diagnosing her Class II cases, but with a rather appalling vista of the tearing out of hair in her efforts to do so. When it was brought to one's notice, it was strange that a classification based on a determination of site where growth had gone wrong, had not been attempted before, and it was certainly fascinating to listen to this train of thought brought to its logical conclusion.

Perhaps Dr. Dockrell would be able to enlarge on his statement that if the rest position was constant, there could not be a constant muscle tone. That was a point of great importance.

Dr. Dockrell had a collection of plywood models which he was willing to show after the meeting, and these would make the whole paper very clear.

Mr. K. E. Pringle, in opening the discussion, said that he felt quite incompetent to do so on the new classification which Dr. Dockrell had presented. The Lecturer had to be congratulated on working on it to the bitter end.

Mr. Pringle's first reaction on seeing Dr. Dockrell's paper in advance was to read

Volume I of Sir Norman Bennett's second edition, 1931, of *The Science and Practice of Dental Surgery,* because he had found for some years that if a student and he could together classify an orthodontic case according to Angle and according to Bennett, they had discovered to their surprise that they both understood quite a lot about the case.

Quite a number of things, of course, were not clear in 1931. Bennett, a very lucid thinker, had stated some of them, and they were most interesting on re-reading, but Bennett had stopped at a certain point in his classification. Mr. Pringle quoted from page 257 of Bennett's Volume I, dealing with Class III, Abnormal Relationship between the Upper and Lower Arches and between either arch and the Facial Contour, and Correlated Abnormal Formation of either arch, due to Developmental Defects of Bone: (1) Vertical, (2) Antero-posterior, and (3) Lateral.

Later, at page 280, Bennett said: " It will be convenient to make use of symbols for the sake of brevity. Let F represent the fixed base. It is not any definite point but represents the forehead, bridge of the nose, and malar bones as the most prominent parts of the unchangeable upper part of the face. It will, of course, be understood that there is much variation in the relationship of these fixed points of the face to one another and to the base of the skull, and that this variation is associated with diversity of racial type and abnormal development; but the sum total of these features forms a fixed base, which for practical purposes cannot be modified." But things were easier in 1931; and it was from there that Dr. Dockrell had continued.

Dr. Dockrell seemed to speak—one was not quite sure whether he meant this—of each bone developing always in relation to other bones. That, of course, was correct, and one could take any point and work from it, but one gained the growing impression that there were spots in the head that were more stable than others. In particular, there was the sphenoid bone. Every other bone around it could be related to the sphenoid and particularly to sella turcica, which must be very near to being the centre of everything.

The Lecturer had spoken also of different rates of growth on the opposite sides of the sutures. That was probably right, because in many cases there was something of a curvature. One began with the suture open. With its gradual closing there was plenty of play at the beginning, and afterwards there would be the serrations, which allowed a certain amount of minor changes. At the same time—and this was where clarification was needed—sutures were in most cases in a straight line in the plane in which they were working; on the skull, each suture appeared as if in a straight line.

Dr. Dockrell: Except the temporal.

Mr. Pringle: But in its actual direction of operation, was it not still in a straight line, in a plane ?

Dr. Dockrell: Yes.

Mr. Pringle: And it could be either way with remodelling a short distance from it.

A good deal had been heard of late about the rest position, of which Dr. Dockrell had spoken. The rest position was not the same for all people. Thompson, in his paper, had shown a cleft palate case with a wide open rest position. It depended, surely, on the way in which a person swallowed. Anybody who used the teeth-apart swallow would have a rest position which was more open than if he did not swallow in that way.

It was sometimes thought, although it could only be partially true, because there were other functions, that the whole mechanism—bones, dental arches and the whole oral musculature—worked together to one end, namely, that food and air did not pass down the pharynx at the same moment. The lungs were filled just before one swallowed, and then every-

thing was sealed off while the teeth were brought into occlusion and the bolus of food was passed back. If there were abnormalities in development or action in any or several of these parts, bones, dental arches or muscles, then there were adaptations to bring about this one thing. that air and food or fluid must not pass back at the same moment.

Mr. Tulley adding his thanks to Dr. Dockrell for his paper, said that he wished to put one or two questions from an anatomical point of view. In classifying Class II malocclusions, in so far as he described the various abnormalities he had seen, Dr. Dockrell could not go far wrong, but when starting to say the reason for the differences in growth in one part and another, one was in purely hypothetical realms.

On the question of sutural growth, this is effected by proliferation of the central connective tissue separating the two bones, and then the new bone is laid down at the edges on either side. Dr. Dockrell had postulated the case that when there was growth on the frontal side of the fronto-maxillary suture the maxilla was displaced downwards and forwards. When there was growth on the maxillary side of this, it enlarged the maxilla. He did not see that this was a reasonable conclusion as most of the change in shape and size of the maxilla was due to surface apposition of new bone and the part played by sutural growth was minimal.

Then there was the problem of dealing with the growth of the mandible. Professor Rushton had shown very clearly in his Presidential address to the Society in 1948, that the mandible should be considered as a long bone, and its inclination should be such that the general direction of growth was from the condyle almost to the point of the chin and should not be considered as an L-shaped bone. Perhaps Dr. Dockrell would clarify the question of sutural growth and his remarks about the antero-posterior growth of the horizontal ramus of the mandible.

Mr. Hovell said that any classification which was to be of any practical value whatsoever, had to be simple. He could not, therefore, see that there could possibly be any improvement upon Angle's classification on the malocclusion of the teeth themselves, because Angle's classification showed exactly the malocclusion of the teeth concerned for any particular case.

To go beyond that meant going into aetiology, for which it was not possible to adopt a classification. Dr. Dockrell himself had said that many millions of combinations were possible, and it was not, therefore, a practical proposition to classify any malocclusion upon the aetiology that produced that malocclusion.

Dr. Dockrell had mentioned growth at the spheno-maxillary suture. The growth at the base of the skull was dependent not upon that suture but rather upon growth at the spheno-occipital synchondrosis. It was known that the growth of the facial skeleton was to some extent dependent upon the growth of the base of the skull. Recent research had shown that certain anomalies in growth at the base of the skull were associated with anomalies in growth of the facial skeleton.

In trying to base a classification upon aetiology, one of the most important points had been completely omitted from the classification. That was, the question of muscle posture and muscle action. No classification of aetiology could be complete without the association with faulty muscle posture and faulty muscle action, of the dento-alveolar deformities produced by them.

It seemed to have been assumed by Dr. Dockrell that excessive overjet and faulty relationship of upper to lower incisors was invariably due to a forward position of the maxilla or to a backward position of the mandible. But it was well known that it may be due rot to a faulty position of the skeletal structures but to a faulty inclination of the teeth entirely due to muscle

posture. It was difficult to see how any classification could be complete without bringing into account malocclusions due to faulty inclinations of the teeth and not necessarily the faulty positions of the bones.

The term "close bite," which Dr. Dockrell had used, was now obsolescent, if not obsolete, and when speaking of this malocclusion one should refer instead to excessive incisor overlap, which was due to the positions and/or axial inclination of the incisor teeth and not to the downward growth of the maxilla or the upward growth of the mandible. The term over-closure should be applied to increase in the freeway space, due either to faulty muscle action, bites of accommodation, or loss of tooth tissue. This is not necessarily accompanied by an excessive incisor overlap.

The alveolar process was entirely governed by the position of the teeth; it was one of the processes of the jaws which was governed by muscular action. There was the basal part of the jaw, and there were the two processes: the alveolar process and the various muscular attachments, the coronoid process, and so on. The muscular attachments and the alveolar bone were really comparable. The latter bone depended upon the position of the teeth, and that in turn depended to a very great degree upon the muscles. And so the alveolar bone could to a great extent be compared with the muscular attachments, depending to a great extent upon muscular function unlike the genetically pre-determined basal bony structure. In view of these criticisms, it was difficult to appreciate that a classification of the kind which had been put forward, and which was so complex, had any great practical value.

Mr. Eastwood added his thanks for the very interesting paper by Dr. Dockrell, who had taken his original slides from tracings. From those had been selected several bones in the maxillary area, upon which the effects of overgrowth had been outlined. But before overgrowth or an abnormality could be discussed, it was necessary to study the so-called normal growth of the individual bones first.

What method should a physician apply to his individual cases by which he could say that a particular bone was normal or abnormal ? It was generally admitted that the best method available today of studying the general problem of the skull growth was the lateral head radiograph, but that method fell short when individual bones were studied.

Dr. Dockrell's drawings had been taken in the two planes of space. What would the result and effect be in the three planes of space ?

Miss Smyth welcomed Dr. Dockrell's paper particularly because it had made everybody think, and that was the greatest compliment that could be paid to any scientific paper. Whether it had a practical value as a classification was a point of secondary importance. For a classification to come into general use it must, as Mr. Hovell had said, be of reasonable simplicity, but the average practitioner of orthodontics would find that the classification under discussion would be very difficult to assimilate and to use in general, everyday work.

But it had tremendous possibilities for research work, and members could do a great deal of good by trying to fit their cases into the classification when engaged on critical research work. The classification seemed to be more a critical survey of the problems which were met with in post-normal occlusions from the etiological standpoint.

Miss Smyth hoped that Dr. Dockrell could give a little more detail about the question of condylar growth; that was a fundamental matter, which had been very much neglected in the past. Much more work was being done on that point now by several people from different angles, and not only from the orthodontic angle.

How did Dr. Dockrell assess the cases

which he classified under defects of condylar growth? That was a most interesting aspect, and one about which, perhaps, more information should be given.

Mr. Chapman said that he had been much impressed by the paper, particularly by the first series of slides and the classification, but he had been somewhat bewildered until being told that there were half a million or so different combinations. If, therefore, one had not grasped all that had gone before, perhaps it was excusable.

He would like Dr. Dockrell to say which of the types mentioned were the most common to be met with in daily practice, and which we were called upon to treat, not always successfully. That was the main question from a practical point of view, quite apart from the scientific and theoretical possibilities. Many of the errors Dr. Dockrell had suggested could not be changed, but his keenly analytical mind which had dissected the problem so absolutely, was to be greatly admired.

When these things were segregated, as the Lecturer had done in his slides, into their various compartments, practitioners got the idea that there was only one error, but that could not often be the case; there would usually be correlated errors.

When teaching students and explaining that the jaws, perhaps, were too small for the teeth—or whichever way one liked to put it—he, Mr. Chapman, tried to impress upon them that it could not be the alveolar processes or the maxilla and mandible alone that were wrong; it must be something spreading further afield comprising other features, and in that case the problem passed off into infinity in the face and skull. They were greatly indebted to Dr. Dockrell for his work.

Dr. Dockrell, replying, expressed his pleasure at the reception accorded to his paper. So many issues had been raised in discussion that it would probably have been the better course to let some of the various speakers, who were so much further advanced, reply to each other

The question of the rest position and muscle tone had been raised by Miss Clinch. As he had said earlier, if there were a constant rest position there could not be a constant muscle tone.

There were a number of peculiar points about rest position, possibly the most peculiar was how frequently people moved out of it; the muscles must be exercised and they do not wish to stay in it. But when in the rest position, in the case of the upper jaw for example, the pull of the elevators of the mandible was balanced by the weight of the mandible and the tone in the depressors and the soft parts which had a certain resistance to stretching or compression. If a patient, in the rest position, with the tone constant, happened to lean forwards, the weight of the mandible would cease to fall entirely upon the elevators. Now if the tone is to remain constant, the mandible must move up further towards the occlusal position. Alternately, if the rest position is maintained, the tone must relatively decrease in the elevators of the mandible or increase in the depressors. He said he had experimented with this by hanging out of bed head foremost and got theimpression that it was the rest positionwhich altered, but that it was very difficult to relax in this position!

One could lie in bed with the legs flexed or extended, either of which was a temporary rest position, yet they must have a different stretch on the muscles.

Patients with a squint could be re-educated. He did not know enough about it to know whether squints are hereditarily determined, but orthoptists certainly claimed cures by exercises to achieve a better position. In severe cases of squint, however, surgery was resorted to and it was surprising that the people who were most in favour of muscles having caused displacements, such as the Angle

Class II, did not have the courage of their convictions and resort to the use of surgery. After all, if a certain malocclusion is due to a hyperactive mentalis muscle, there would be nothing to prevent the section of some of the fibres. The possibility was most interesting because, if these malocclusions were of a muscular origin, a vast operative field would lie open, in which work could be done.

Dr. Dockrell had endured a few awful moments during Mr. Pringle's remarks because, he had to confess, he had never read Sir Norman Bennett's book. The sphenoid was, as Mr. Pringle had said, the most stable point, the keystone in the skull; but the sphenoid grew from birth. If it were assumed that there were individual variations in the sphenoid, it would have exercised varying effects in different directions. It could be agreed that the rest position was different for different people, but the puzzling feature about the increases in the free-way space and the problems arising from it was the extent to which they were due to variations in the degree of alveolar growth upwards and downwards.

The easiest way to deal with Mr. Tulley's questions was to refer them to Mr. Pringle. One could, perhaps, accept the possibility of different growths on different sites of the same suture, in view of the high degree of independent variation of those bones; but that was only a hypothesis, like the whole of the paper. As for dividing up the different growth sites in the mandible, he had been forced to do that because cases were found, or were thought to have been found, where there appeared to be a shortening of the horizontal ramus anteroposteriorly and a decrease in the anteroposterior length of the ascending ramus. The attitude to that depended on one's belief about what was happening at the anterior border of the ascending ramus. If one believed that bone resorption is taking place at the anterior border of the ascending ramus then a decrease in growth at the condyle could result in a shortened horizontal process. If that resorption were not accepted, then one had to postulate at least a cause operating at two different sites in cases where the horizontal ramus was short and the ascending ramus was short too. It had to be repeated, however, that all these terms had been used relative to the other bones and not in an absolute manner.

There was a great deal about which to disagree as far as Mr. Hovell was concerned. Modifications in Angle's classification certainly were necessary. Every student knew what was meant by "Angle Class II, Division I" or "Division II," but further sub-division was needed. The paper specifically had not touched aetiology. It was impossible to see how a post-normal occlusion could arise without the bone having been modified in some way unless there was an excessively mobile joint which permitted the mandible to move backwards. Thompson had in no way suggested that there was undue mobility of the joint. The paper specifically said that the question that the mandible could only go back one millimeter from the normal occlusion position, would have to be reviewed. One could not believe that faulty inclinations of teeth were entirely due to muscles. Just how important a factor they were it was difficult to say, but that they were the main factor was extremely doubtful.

On the question of which particular bone was or was not normal, it was often quite impossible to tell, although everyone did so clinically, even though that should not perhaps be done. The final position to arrive at was the factors for and against malocclusion—and there one ought to sit down and never again open his mouth. But the diagnosis must be pushed a little further, even though it meant using approximations in many cases and that many diagnoses were only wild guesses.

The paper, in that it used only two planes, was like the Angle classification.

The paper admitted the possibility of growth in width in the maxilla and in the mandible as factors, but as in dealing with the Angle classification, the only concern with them was the way in which they might modify the anteroposterior arch relationship. There could well be found an enormously wider upper arch, and an enormously long and narrow lower arch. That in itself, quite apart from the other malocclusions, could yield a postnormal occlusion; but Angle was not interested in that.

Dr. Dockrell thanked Miss Smyth for her kind words. He was not a research worker, and could not therefore fully assess the theoretical value of his classification to those engaged in research, but he himself did try to use it in practice. Sometimes he had had trouble in deciding exactly where a case should go, but that was bound to happen with any classification. He was not concerned with aetiology, and did not know why or how defects of condylar growth arose, and without an X-ray it was impossible even to decide if they were present. Where he suspected that the cause had operated distal to the last showing molar, it usually seemed to him as if the whole lower arch had been placed backwards. Whether that was of condylar or glenoid origin, he could only guess. People with X-ray machines would know a great deal more. By going through the literature on these analytical investigations, it was possible to see that all these variations did occur.

In reply to Mr. Chapman's question of what were the common types to be met with, those encountered in Dublin appeared to be displacements of the maxilla, namely, cases in which the maxilla appeared, to the profile view, in an anterior position without any distinguishable markedly large maxilla. Although not the commonest, that was one of the common syndromes. The other greatest and the most common syndrome in Dublin was a small lower jaw—what could be called a mandibular position—as if the cause had operated behind the lower teeth somewhere distal to that point. If the patients had been thumb suckers, there was usually also a combination of some degree of maxillary alveolar forward movement. He could not dissect the problem absolutely, despite his wish to do so, and all a practitioner could do was to attempt to describe what he saw and his reasons for believing that it had arisen in a certain way.

Dr. Dockrell had not come over with the intention of convincing everybody that no household was complete without his classification. It represented only his thoughts on the subject, and he was sure that there were many glaring inaccuracies. He concluded by once again thanking his audience for the way in which they had received both himself and his classification.

A CLASSIFICATION OF POST-NORMAL OCCLUSIONS

(R. B. Dockrell, M.A., M.B., B.CH., B. DENT.SC.)

1. Ballard, C. F. Recent work in North America as it affects Orthodontic Diagnosis and Treatment. *Dental Record* v. 71 ; pp. 85-97, 1951.
2. Lundstrom, Axel F., Malocclusion of the Teeth regarded as a problem in connection with the apical base, 1923.
3. Moyers, R. E., Temporo-mandibular muscle contraction patterns in Angle class II division I malocclusions ; an electromyographic analysis A.J.O. v. 35 ; pp. 837-857, 1949.
4. Moyers, R. E., Electromyographic analysis of muscles in temporo-mandibular movement A.J.O. v. 36 ; 481-515, 1950.
5. Thompson, J. R., Oral and Enviromental Factors as Etiological Factors in Malocclusion of the Teeth A.J.O. 35 ; 33-53, 1949.
6. Wylie, W. L., The Assessment and Anteroposterior Dysplasia, The Angle Orthodondist, Vol· 17, No. 3 and 4, pp. 97-109, 1947.

MAXILLARY CAUSES OF ANGLE CLASS II MALOCCLUSION

Site of Primary Abnormality	*Part of Jaw Affected*	*Agency*		*Manner in which cause acts*	*Profile of Lateral X-ray*	*Diagnosis*
A. Cranial base and frontal bone	whole maxilla	"position"	a.	displacement forwards	superior prenormal	anterior position of a normal sized maxilla
			b.	displacement downwards	inferior postnormal	caudal position of a normal sized maxilla
B. Maxilla	1. whole maxilla	"size"		generalised increase in growth	superior prenormal	abnormally large maxilla
		"shape"	a.	increased growth downwards	inferior postnormal	abnormally long maxilla in the cranio-caudal dimension
			b.	increased growth antero-posteriorly	superior prenormal	abnormally long maxilla in the anterior-posterior dimension
			c.	diminished lateral growth	normal	abnormally narrow maxilla

Site of Primary Abnormality	*Part of Jaw Affected*	*Agency*		*Manner in which cause acts*	*Profile of Lateral X-ray*	*Diagnosis*
B. Maxilla	2. alveolar process and teeth	"position"		displacement forwards	superior prenormal (skeletal Class I)	anterior position of maxillary alveolar process with an other-wise normal maxilla
		"size"		generalised increase in growth	superior prenormal (skeletal Class I)	abnormally large alveolar process
		"shape"	a.	increased growth downwards	inferior postnormal	abnormally long maxilla; cranio-caudal dimension (inseparable from maxillary "shape" a)
			b.	increased growth antero-posteriorly	superior prenormal (skeletal Class I)	abnormally long maxillary alveolar process in an antero-posterior direction
			c.	diminished lateral growth	normal	abnormally narrow maxillary alveolar process

TABLE 1

MANDIBULAR CAUSES OF ANGLE CLASS II MALOCCLUSION

Site of Primary Abnormality	*Part of Jaw Affected*	*Agency*		*Manner in which cause acts*	*Profile of Lateral X-ray*	*Diagnosis*
C. Glenoid fossa and temporal bone	whole mandible	"position"	a.	displacement backwards	inferior postnormal	posterior position of normal sized mandible
			b.	displacement upwards	inferior postnormal	posterior position of normal sized mandible
D. Mandible	1. condyle	"size"		generalised decrease in condylar growth	inferior postnormal	small ascending ramus of mandible
		"shape"	a.	diminished growth backwards	inferior postnormal	ascending ramus of madible small anteroposteriorly
			b.	diminished growth upwards	inferior postnormal	short ascending ramus of mandible
			c.	increased growth forwards	inferior postnormal	diminished angle between horizontal and ascending rami.

Site of Primary Abnormality	*Part of Jaw Affected*	*Agency*		*Manner in which cause acts*	*Profile of Lateral X-ray*	*Diagnosis*
D. Mandible	2. horizontal ramus	"position"		displacement backwards	inferior posterior	posterior position of horizontal ramus in an otherwise normal mandible; probably only traumatic in origin
		"size"		diminished growth in all directions	inferior posterior	small horizontal ramus with a normal ascending ramus
		"shape"	a.	increased upward growth	inferior posterior	increase in cranio-caudal length of horizontal ramus of mandible; otherwise normal
			b.	decreased forward growth	inferior posterior	horizontal ramus short in an antero-posterior dimension; otherwise normal
			c.	increased growth laterally	normal	abnormally wide horizontal ramus of mandible

TABLE 1 *continued.*

MANDIBULAR CAUSES OF ANGLE CLASS II MALOCCLUSION

Site of Primary Abnormality	*Part of Jaw Affected*	*Agency*		*Manner in which cause acts*	*Profile of Lateral X-ray*	*Diagnosis*
D. Mandible	3. alveolar process and teeth	"position"		displacement backwards	normal	posterior position of alveolar process and teeth in an otherwise normal mandible; probably only traumatic in origin
		"size"		diminished growth in all directions	normal	small alveolar process of mandible superimposed on a normal mandible
		"shape"	a.	increased growth upwards	normal	abnormally deep alveolar process of mandible craniocaudally; otherwise normal (inseparable from horizontal ramus "shape" a).
			b.	diminished forward growth	normal	abnormally short alveolar process of mandible anteroposteriorly; otherwise normal
			c.	increased lateral growth	normal	abnormally wide mandibular alveolar process

TABLE 1 *continued*

Site of Primary Abnormality	*Part of Jaw Affected*	*Factors favouring the production of an Angle Class II malocclusion*	*Factors against the production of an Angle Class II malocclusion*
A. Cranial Base and Frontal Bone	whole maxilla	Displacement forwards. Displacement downwards	Displacement backwards. Displacement upwards
B. Maxilla	1. whole	Increased forward growth Increased downward growth	Decreased forward growth Decreased downward growth
	2. alveolar process and teeth	Displacement forwards Displacement downwards Increased forward growth Increased downward growth (Decreased lateral growth)	Displacement backwards Displacement upwards Decreased forward growth Decreased downward growth (Increased lateral growth)
C. Temporal Bone and Glenoid Fossa	whole mandible	Displacement backwards Displacement upwards	Displacement forwards Displacement downwards
D. Mandible	1. condyle	Decreased backward growth Decreased upward growth Increased forward growth, i.e. change in direction	Increased backward growth Increased upward growth Decreased forward growth, i.e. change in direction
	2. horizontal ramus	Displacement backwards Displacement upwards Decreased forward growth Increased upward growth (Increased lateral growth)	Displacement forwards Displacement downwards Increased forward growth Decreased upward growth (Decreased lateral growth)
	3. alveolar process and teeth	Displacement backwards Decreased forward growth (Increased lateral growth)	Displacement forwards Increased forward growth (Decreased lateral growth)

TABLE 2

CLINICAL TYPES OF ANGLE CLASS II MALOCCLUSION

Site	Agency	Discrepancy in Bone/Tooth Size
Maxillary Causes		
1. Whole maxilla	Position Size	No discrepancy in either jaw. $\left(\frac{=}{=}\right)$
2. Alveolar process and teeth	Position Size	Discrepancy in upper jaw: + or − $\left(\frac{+\text{ or }-}{=}\right)$
Mandibular Causes		
1. Whole mandible	Position Size	Discrepancy in lower jaw: + or − $\left(\frac{=}{+\text{ or }-}\right)$
2. Condyle	Position Size Shape	
3. Horizontal ramus	Position Size	Discrepancy in both jaws: + or −
4. Alveolar process and teeth	Position Size	$\left(\frac{+}{+}\text{ or }\frac{+}{-}\text{ or }\frac{-}{+}\text{ or }\frac{-}{-}\right)$

TABLE 3

Ordinary Meeting

held on 8th January.

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1., on Monday, 8th January, 1951, at 7.30 p.m. Miss L. M. Clinch, President, occupied the Chair.

The Minutes of the Annual General Meeting, held on 14th December, 1950, were read, confirmed and signed.

The president said that the British Dental Association had decided to open a fund for the purpose of presenting Dr. Lilian Lindsay with her portrait. All the members of the Society owed a very great deal to Dr. Lindsay, who had been a Vice-President since 1940 and whose help and advice were of the greatest value to the Council. She was sure that the members would wish a worthy portrait to be produced. Subscription papers could be obtained from her or from the Honorary Treasurer or the Honorary Secretary of the Society.

The president then welcomed the visitors who were present and invited them to take part in any discussion which might ensue.

The following candidates for membership of the Society were elected *en bloc* by show of hands:—

Miss C. Jefferson, L.D.S. (U. Manc.), 20, Thames Eyot, Twickenham.

Mr. C. C. Knowles, B.D.S. (L'pool), 49, Whitefield Road, Stockton Heath, Warrington.

Mr. J. G. H. Vidler, L.D.S., R.C.S.(Eng.) 11, Sheet Street, Windsor.

Mr. B. M. Bilton, B.D.S. (Lond.), L.D.S., R.C.S. (Eng.), 3, Cavendish Road, Sutton, Surrey.

Mr. P. H. Burke, B.D.S., L.D.S. (Dunelm), H.D.D., R.C.S. (Edin.), 5, Westward Green, West Monkseaton, Northumberland.

Mr. A. W. Eastwood, B.D.S. (L'pool), M.Sc. (Orthodontics), Ann Arbor, Michigan, U.S.A., 27, Gloucester Place, W.1.

The following Presidential Address was then delivered:—

"*An Analysis of Serial Models Between Three and Eight Yeals of age.*"

By Miss L. M. Clinch.

Ordinary Meeting

held on 12th Fearuary.

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1., on Monday, February 12th, 1951, at 7.30 p.m. Miss L. M. Clinch, President, occupied the Chair.

The Minutes of the previous meeting, held on January 8th, 1951, were read confirmed and signed.

The President welcomed any visitors who were present and invited them to take part in any discussion which might ensue.

The following recently elected members

were introduced to the President and signed the Obligation Book: Mr. A. W. Eastwood and Miss C. C. Jefferson.

The following candidates for membership of the Society were duly elected by show of hands:—

Mr. A. J. P. Cousins, B.D.S., L.D.S., R.C.S., 10, Lansdown Place, Clifton, Bristol.

Mr. J. Knight, L.D.S., Burway Chambers, Church Stretton, Salop.

The following short communication was then read:—

"*The Occlusal Effects of Tuberculated Lateral Incisors*"
By Mr. J. S. Beresford

The following paper was then read:—

"*Recent work in some North American Dental Schools as it affects Orthodontic Diagnosis and Treatment*"
By Mr. C. F. Ballard

On a motion of the President, a vote of thanks was accorded to Mr. Beresford for his short communication and to Mr. Ballard for his paper.

Ordinary Meeting

held on 12th March.

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, March 12th, 1951, at 7.30 p.m. The President, Miss L. M. Clinch, occupied the Chair.

The minutes of the previous meeting, held on Monday, February 12th, 1951, were read and confirmed.

The President said she had one announcement to make. The Executive of the European Orthodontic Society would like to take this opportunity of informing any of its members who were present that owing to the enormous increase in the cost of paper and labour the price of producing the Transactions of the 1949 meeting had risen above the level which the finances of the Society could meet. The work had had to be stopped, and all the time prices were rising so that it was urgent that the Society should be able to give the order to the printers to proceed.

The only way in which this could safely be done was to have the money guaranteed by members of the Society, spreading out the cost as widely as possible. The sum needed was about £100 or slightly more. Offers of guarantees had already been received from some members, varying from £2 to £10. If anyone would be good enough to guarantee similar amounts, would they please tell the Secretary, Mr. Gray, the Treasurer, Mr. Wells, or the Editor, Miss Smyth after the meeting.

It should be clearly understood that all amounts guaranteed were confidently expected to be released or refunded, if called in, at the meeting of the Society in Norway in June, 1951, when the matter would come before the whole Society. The Executive of the European Orthodontic Society thanked the British Society for the Study of Orthodontics for allowing this announcement to be made.

The President welcomed any visitors who might be present and invited them to look upon themselves as members for the evening and to take part in the discussion.

Three members who were attending for the first time were introduced to the President.

The following candidates for election were admitted *en bloc*:

Mr. A. W. Gottlieb, D.D.S. (New York), L.D.S.R.C.S. (Eng.), 11, Bouverie Square, Folkestone, Kent.

Miss J. S. W. Greenslade, B.D.S. (New Zealand), Helen Graham House, 57, Great Russell Street, London, W.C.1.

Mr. J. D. McEwen, L.D.S. (Glasgow), Eastman Dental Hospital, Gray's Inn Road, London, W.C.1.

Mr. E. McLaren Hope, L.D.S.R.C.S. (Edin.), 200, Musters Road, West Bridgford, Nottingham.

Mr. G. H. Roberts, B.Ch.D., L.D.S. (Leeds), D.D.S. (Toronto), Eastman Dental Hospital, Gray's Inn Road, London, W.C.1.

Mr. J. J. Tittle, L.D.S. (Eng.), Springfield, St. Mary's Road, Portishead, Nr. Bristol.

Mr. R. C. Churchyard, L.D.S.R.C.S. (Eng.), Eastman Dental Hospital, Gray's Inn Road, London, W.C.1.

Miss E. M. Andrew, L.D.S. (Eng.), 19, Hillcrest Road, Bramhall, Cheshire.

The President called upon Mr. H. Schachter to make a Short Communication.

Mr. H. Schachter made the following Short Communication:

"*A Treated Case of Transposed Upper Left Canine*"

The President called upon Mr. A. J. Walpole Day to read a Short Paper.

Mr. A. J. Walpole Day read a Short Paper on

"*The Effect of the Condylar Cartilage on the Growth of the Mandible*"

The President called upon Mr. E. K. Breakspear to read a Short Paper.

Mr. E. K. Breakspear read a Short Paper on

"*Sequela of Early Loss of Deciduous Molars*"

A vote of thanks to Mr. Schachter, Mr. Walpole Day and Mr. Breakspear for their papers, which was proposed by the President, was carried by acclamation, and the meeting then terminated.

Demonstration Meeting

held on 7th May.

The Demonstration Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1. on Monday, May 7th, 1951.

The Minutes of the previous Ordinary Meeting, held on March 12th, 1951, were read, confirmed and signed.

The following candidates for election were admitted en bloc:

Mr. F. Jones, L.D.S.,(Eng.), Treverward, Broadway, Llandrindod Wells.

Mr. F. E. N. Preston, L.D.S.R.S.C.(Eng.), 57, Tulgarth Mansions, Barons Court, London, W.1.

Mr. V. G. Rice, L.D.S., 80, Wimborne Road, Southend-on-Sea.

The following Demonstrations were given:

Mr. J. S. Beresford : *Tubular Lingual Arches.*

Mr. M. A. Kettle : *Orthodontic Treatment of Cleft Palate according to Harvold's Method.*

Mr. H. L. Leech : *Methods of Regaining Lost Premolar Space in the Lower Arch.*

Mr. W. Russell Logan : *Malocclusion in the Deciduous Dentition.*

Mr. W. J. Tulley : *The Applied Anatomy of Orthodontics.*

Miss P. Watkin : *Treated Cases.*

Mr. N. Wild : *A Portable Craniostat.*

Mr. K. G. Wongtschowski : *The Time of Therapeutic Approach.*

Ordinary Meeting

held on 8th October.

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, October 8th, 1951, at 7.30 p.m. Miss L. M. Clinch, President, occupied the Chair.

The Minutes of the Demonstration Meeting, held on May 7th, 1951, were read, confirmed and signed.

The PRESIDENT said it was with deep regret that she reminded the members of the death of Dr. Sim Wallace, one of the original members of the Society and, with the exception of the Presidential Address, the first of the members to read a paper before the Society. That paper had been read in February, 1908; its title was "Science and Empiricism in Orthodontia," and it was a plea that orthodontic diagnosis and treatment should be based on a knowledge of etiology and not on signs and symptoms. That was, to her mind, typical of Dr. Sim Wallace. He would be remembered especially for his work on the cause and prevention of caries. He had retired from practice some years ago but had always been ready to help and advise those who tried to carry on his work even in a small way.

The following candidates for membership of the Society were elected *en bloc* by show of hands:—

Mr. A. C. Campbell, B.D.S. (L'pool), 75, Lichfield Street, Hanley, Stoke-on-Trent.

Mr. M. L. H. Pearsall, L.D.S., R.C.S. (Eng.), 8, Causeway, Horsham, Sussex.

Mr. R. W. Halliday, B.D.S. (Sydney), D.D.S. (Toronto), 127, Macquarie Street, Sydney, New South Wales, Australia. (Corresponding Member).

The following short communication was then read:—

"*A Removable Appliance for Retraction of Canines*"

By MR. B. C. LEIGHTON

The following Paper was then read:—

"*Cephalometric Radiography in Diagnosis and Treatment Analysis*"

By MR. A. W. EASTWOOD, B.D.S. (L'ool), M.Sc. (Orthodontics), Ann Arbor, Michigan, U.S.A.

On the motion of the President, a vote of thanks was accorded to Mr. Leighton and Mr. Eastwood, and the meeting then terminated.

Ordinary Meeting

held on 12th November.

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1., on Monday, November 12th, 1951, at 7.30 p.m. Miss L. M. Clinch, President, occupied the Chair.

The Minutes of the Ordinary Meeting held on October 8th, 1951, were read, confirmed and signed.

The PRESIDENT read the following notice which appeared on the Agenda: "As the agenda for the December Annual General Meeting will not necessarily reach members twenty-one days prior to the date fixed, attention is drawn to Rule XX, whereby nominations for Council office made by four properly qualified members,

received at least twenty days prior to the meeting, will be accepted. The Council nominations for officers for 1952 will be set forth in the December agenda as usual."

Mr. Allan Courtney Campbell, a recently elected member, was introduced to the President and signed the Obligation Book.

The following candidate for membership of the Society was elected by show of hands:—

Miss V. Marcus, L.D.S., R.C.S. (Eng.), 50, Aylestone Avenue, Brondesbury Park, N.W.6.

The President, in introducing Professor Friel, who was to give the Fifth Northcroft Memorial Lecture, said that he had been President of the Society in 1924 and since 1910 had contributed handsomely to the Transactions of the Society. Indeed, his contributions were a part of the foundation of orthodontics, on which all orthodontists tried to build. He had studied orthodontics and had taught a great many other orthodontists to do so.

The following Lecture was then delivered:

"*The Development of the Occlusion of the Teeth*"

By Professor S. Friel

On the motion of the President, a vote of thanks was accorded to Professor Friel for his lecture, and the meeting then terminated.

The reports of the Hon. Treasurer, Secretary, Librarian, Editor and Curator were read and adopted as follows:

Report of the Hon. Treasurer for Year Ended 30th September, 1951

I am glad to announce, in this my last report, that the accounts show a balance of excess of income over expenditure of £405. This is the first year, since prior to 1943 (when the Society's accounts were first audited by professional accountants) that the Society has paid its way, taking the combined balances for the intervening years.

The present satisfactory state of affairs is due to raising the subscription to £3 3s. 0d., but there have been other favourable items, for example, the sale of Transactions £85 this year, against £16 in 1950; for this thanks are due to the Hon. Librarian for obtaining and despatching orders, and to a number of members who have given past issues of the Transactions which, as regards some years, are surplus to the Society's requirements; the Librarian refers to this in detail in his report.

Other items in the accounts show small reductions which may be recognised by comparison with the figures for the previous year.

It is a pleasure to hand over the Society's finances to my successor, Mr. J. S. Beresford, in such form that the drain on the Society's reserves has ceased. I am glad to take the opportunity to thank the members for their support of the policy which the Council recommended, and has enabled a satisfactory financial position to be achieved.

Report of the Honorary Secretary

Seven meetings were held during the year, and the average attendance has been 93.7. This figure compares very favourably with last year's average of 78 per meeting.

Twenty-three new members have been elected, bringing the total as at December 31st to 367.

There has been one death and on December 31st thirteen resignations become effective, so that on January 1st, 1952, the membership is expected to be 354, consisting of:—

132	London Members
181	Provincial Members
6	Honorary Members
35	Corresponding Members

From the applications for copies of the Transactions from schools all over the world which have been passed to the Hon. Librarian, it is obvious that the reputation of the Society stands high everywhere: coupled with the markedly increased attendances at meetings, this augurs well for the future.

REPORT OF THE HONORARY LIBRARIAN

The issue of the catalogue of books in the Society's library, for the first time since 1926, has led to a big increase in the turnover of books. Members far removed from London are the chief borrowers and, on occasion, it has been necessary to ask for the return of books to satisfy the next borrower. Not only the lending of books but the preparation of reference lists is now one of the services of the library. I must apologise for the delays that sometimes happen in the sending out of books, but I hope I shall be excused.

The Transactions of the European Orthodontic Society for 1948 and 1949 have been added to the shelves and gifts of past Transactions of the Society and reprints have been received from Mr. J. E. Spiller and Mr. Harold Chapman, both past Presidents. The American Dental Association has made a truly magnificent gift of the Index of Periodical Dental Literature from 1876 to 1941.

The sale of past and current Transactions continues and I like to think that the increase of standing orders from libraries in Scandinavia, the United States, Canada and New Zealand is an indication of the rising standard of our Transactions and the prestige of this Society.

REPORT OF THE HONORARY EDITOR

Once again I must apologise for the delay in the publication of the Transactions. This is almost entirely outside my control, as all the matter has been in the hands of the printers for many months.

Most of the papers, casual communications, and demonstrations have been published in the Dental Record, and similarly, we are not far behind with the publication of the 1951 programme; so far, most of the 1951 programme has also been published in this journal soon after being read at the Society's meeting. Some delay is caused because the readers of papers do not have them ready for publication at the time they are presented to the Society.

The 1951 Transactions should be out much sooner after the end of the year, although I and previous editors have made similar promises which we have not been able to keep.

Once again, I think you will agree with me that the *Dental Record* are to be congratulated on the high standard of their printing and their reproduction of the illustrations.

REPORT OF THE HONORARY CURATOR

I have to report that during the past year the Museum has received models from Mr. E. C. Dimock, Mr. Lindo Levien and some examples of fixed apparatus from Mr. Chapman.

We were able to display some of the Museum material at the Annual General Meeting of the British Dental Association this year, thanks to the kindness of the Royal Dental Hospital in lending us some lockable specimen cases. The material included the Northcroft face masks and serial models which are some of our most prized exhibits.

For the information of new members the Museum is housed next door, No. 28, Portland Place, adjoining the Museum of the Institute of Public Health and Hygiene, and is open daily from 9.30 a.m. until 5.0 p.m.

If any members have interesting or unusual material I would be grateful if they would present models, photographs and X-rays, if possible, to the Museum.

Ordinary Meeting

held on 10th December.

The Annual General Meeting for 1951 was held at Manson House, 26, Portland

Place, London, W.1, on Monday, 10th December, 1951, at 7. p.m. Miss L. M. Clinch, President, occupied the Chair.

The Minutes of the previous meeting were read, confirmed and signed.

The following Officers and Councillors, as nominated by the Council, were elected for 1952:

President:	Mr. Harold Chapman.
Immediate Past President:	Miss L. M. Clinch.
Vice-Presidents:	Dr. L. Lindsay, Mr. J. F. Pilbeam, Mr. Trevor Johnson, Mr. K. E. Pringle.
Secretary:	Mr. Howell Richards.
Treasurer:	Mr. J. S. Beresford.
Curator:	Mr. W. J. Tulley.
Editor:	Mr. C. F. Ballard.
Librarian:	Mr. A. G. Taylor.
Councillors:	Mr. W. Russell Logan, Mr. J. H. Hovell, Mr. S. E. Wallis.

Mr. S. B. Newton and Mr. T. L. Winn were elected Auditors.

The Treasurer was congratulated on the Society's very satisfactory financial position, and in reply to a question explained that the drop in postages from £36 to £24 was not so much a reduction of expenditure as a transfer to another heading of the cost of sending out the transactions.

The PRESIDENT expressed the Society's gratitude to the Americans for sending to the Library the Dental Index, which was now out of print and unprocurable.

The following candidate for membership of the Society was elected by show of hands:

Mr. L. D. Carton-Kelly, L.D.S., R.C.S. (Eng.), Gloncarrig, North Common, Weybridge, Surrey.

The following Lecture was then delivered:

" *A Classification of Post-Normal Occlusion* "

By DR. R. B. DOCKRELL

The vote of thanks was carried with acclamation.

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

Balance Sheet and

Income and Expenditure Account

FOR THE YEAR ENDED 30th SEPTEMBER, 1951

FREDK. B. SMART & COMPANY, CHARTERED ACCOUNTANTS
22, Queen Street, London, E.C.4.

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

INCOME AND EXPENDITURE ACCOUNT for the Year ended 30th September, 1951.

1950 £ s. d.		£ s. d.	£ s. d.
10 10 0	To Museum Rent (Formerly Storage Rent)		10 10 0
79 16 11	,, Printing and Stationery ..	80 13 6	
501 0 1	,, Reserve for Cost of Transactions	444 1 4	
			524 14 10
36 18 4	,, Postage		24 17 10
1 10 0	,, Lantern and Film Expenses	2 0 0	
45 0 0	,, Hire of Hall	45 0 0	
31 10 0	,, Reporting	31 10 0	
56 8 0	,, Refreshments	51 6 0	
			129 16 0
2 4	,, Telephone and Telegrams		—
	,, Travelling Expenses:— Dr. James Scott, 9th October, 1950, deputising for Mr. N. B. B. Symmons		5 8 11
5 5 0	,, Audit and Accountancy ..		8 8 0
3 7 11	,, Insurance		3 8 6
24 14 0	,, Library and Journals ..		24 10 0
	,, Northcroft Memorial Lecture:— Honorarium Professor F. Wood-Jones		26 5 0
43 9 5	Expenses of Professor R. Selmer Olsen		—
15 4	,, Sundries and Hire of Equipment for Meetings ..		6 10 6
30 11 6	,, Depreciation:— Furniture and Office Equipment		30 11 6
—	,, Excess of Income over Expenditure for the Year ..		405 7 9
£870 18 10			£1,200 8 10

1950 £ s. d.		£ s. d.	£ s. d.
	By Members' Subscriptions:		
	1951 Subscriptions ..	1,049 5 9	
	1949 and 1950 Subscriptions paid in 1951 ..	28 17 9	
	(Subscription raised to £3 3s. 0d.)		1,078 3 6
16 5 0	,, Sales of Transactions ..		85 0 0
12 10 0	,, Accrued Interest on Savings Certificates		12 10 0
17 5 4	,, Interest on $2\frac{1}{2}$% Consolidated Stock		17 5
—	,, Interest on Post Office Savings Bank Account ..		7 10
91 10 0	,, Excess of Expenditure over Income for the year ..		—
£870 18 10			£1,200 8 10

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

BALANCE SHEET as at 30th September, 1951.

1950 £ s. d.		£ s. d.	£ s. d.
	Accumulated Fund:—		
	Balance at 1st October, 1950	1,008 3 8	
	Add: Excess of Income over Expenditure for the year ..	405 7 9	
1,008 3 8			1,413 11 5
	Creditors:—		
—	Transactions—1949	438 11 4	
1,000 0 0	Transactions—1950 and 1951 (Estimated by Hon. Treasurer)	1,000 0 0	
22 10 0	Hire of Hall	22 10 0	
7 17 6	Museum Rent (Formerly Storage Rent	7 17 6	
11 0 0	Refreshments	12 8 0	
10 9 0	Subscriptions in Advance ..	12 12 0	
—	Printing and Stationery ..	5 4 0	
—	Postage	6 9 5	
			1,505 12 3
£2,060 0 2			£2,919 3 8

S. B. NEWTON }
T. L. WINN } *Hon. Auditors.*

HAROLD CHAPMAN, *Hon. Treasurer.*

1950 £ s. d.		£ s. d.	£ s. d.
	Furniture and Office Equipment:		
	Balance at 1st October, 1950	489 4 0	
	Less: Depreciation at 5% per annum on cost	30 11 6	
489 4 0			458 12 6
	Debtors:		
7 17 6	1951 Subscriptions received since 30th September, 1951		6 16 6
	Investments:		
375 0 0	500 National Savings Certificates Seventh Issue at cost	375 0 0	
37 10 0	*Add:* Accrued Interest to date	50 0 0	
		425 0 0	
575 14 0	£691 5s. 10d. $2\frac{1}{2}$% Consolidated Stock at cost ..	574 14 0	
	(*Approximate Market Value* £874)		1,000 14 0
	Cash at Bank:		
171 1 9	Westminster Bank Ltd. ..	1,040 5 2	
400 0 0	Post Office Savings Bank ..	407 10 0	
			1,447 15 2
	Cash in Hand:		
2 1 1	Hon. Treasurer	4 12 6	
1 11 10	Hon. Secretary	13 0	
			5 5 6
£2,060 0 2			£2,919 3 8

Certified in accordance with the Books and Vouchers of the Society. We have verified the Investments and Cash at Bank.

FREDK. B. SMART & Co.,
Chartered Accountants.
22, Queen Street,
London, E.C.4.

2nd November, 1951.

INDEX